Raytheon Anschütz

SYNAPSIS System Manual
Version: E01.00 or higher

System Manual

Radar, ECDIS, Nautoconning, HD Conning and Multifunction Console (MFC) and for Integrated Navigation System (INS)

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CHANGE HISTORY

Date	Change
March 2015	Display Standard IEC 62288 edition 1 and new edition 2 integrated. Section 6.7 Required Redundancies (new). Section 6.8 Recommendations for System Design (new) New System Monitoring Alerts (>>SWITCH<<). New Status Display, new NAV Display. License Convention.
July 2015	Chapter 12 Power Supply Failure new.

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0 General

The present manual has been drawn up as a description and reference book.
It will help answer questions and will solve problems in the quickest possible manner.

Before operating the equipment read and follow the instructions and hints in this manual.

For this purpose refer to the table of contents and read the corresponding chapters thoroughly.
If you have any further questions, please contact us on the following address:

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Since errors can hardly be avoided in the documentation in spite of all efforts, we should appreciate any remark and suggestion.
Subject to alterations.

0.1 Safety Regulations

The following safety symbols are used in this manual:

WARNING 	Warning statements indicate a hazardous situation that, if not avoided, could result in death or serious injury.
	Caution statements indicate a hazardous situation that, if not avoided, could result in minor or moderate injury.
	Notes indicate information considered important but not hazard related.

0.2 Product and Performance Standards

Standards	Description
IEC 62288 (edition 1 and 2)	Maritime navigation and radio communication and systems – Presentation of navigation-related information on ship borne navigational displays – General requirements, methods of testing and required results.
IEC 60945	Maritime navigation and radio communication equipment and system – General requirements-Methods of testing and required test results.
IEC 61924-2:2012	Maritime navigation and radio communication equipment and systems – Part 2 Modular Structure for INS – Operational and performance requirements, methods of testing and required test results.
IEC 6116	Maritime navigation and radio communication equipment and systems - Digital interfaces.
IMO MSC 252 (83)	Adoption of the revised performance standards for Integrated Navigation Systems (INS).

0.3 Further Documents

Title	Documentation No.
Synapsis Radar Service Manual and Drawings	4265
Synapsis ECDIS Operator Manual	4276
Synapsis Nautoconning Manual	4278
Synapsis HD Conning	4285
Synapsis Service Tool for Nautoscan NX Documentation	4280

0.4 List of Abbreviation

Term	Description
ACK	Acknowledge
AIS	Automatic Identification System
ALR	Alarm
ARPA	Automatic Radar Plotting Aid
AUTO	Automatic
BAM	Bridge Alert Management
BGV	Berufsgenossenschaftliche Vorschriften
BIP	Bridge Integration Platform
BNWAS	Bridge Navigational Watch Alarm System
BT	Bottom Track
CAM	Central Alert Management
CCRP	Consistent Common Reference Point
CCRS	Consistent Common Reference System
CPA	Closest Point of Approach
CTW	Course True Water
DBK	Depth Below Keel
DBS	Depth Below Surface
DBT	Depth below transducer
DGPS	Differential Global Positioning System
DPT	Depth of water
EBL	Electronic Bearing Line
ECDIS	Electronic Chart Display and Information System
EPFS	Electronic Position Fixing System
GGA	Global Positioning System Fix Data, Time, Position and fix related data for a GPS receiver

Term	Description
GLL	Geographic Position - Latitude/Longitude
GNS	Fix Data
GPS	Global Positioning System
HDG	Heading - Deviation & Variation
HDT	Heading - True
HMI	Human Machine Interface
IEC	International Electro technical Commission
IMO	International Maritime Organization
INS	Integrated Navigation System
ITM	Integrated Target Management
LAN	Local Area Network
MAN	Manual
MFC	Multifunction Console
MFD	Multifunction Display
MHU	Humidity
MKD	Minimum Keyboard and Display
MMSI	Maritime Mobile Service Identify
MSC	Marine Safety Committee
MTW	Water Temperature
MWD	Wind Direction and Speed
MWV	Wind Speed and Angle
NMEA	National Marine Electronics Association
NMEA0183	Standard protocol for data transfer
NRX	NavTex
NSR	National Standard Report
PCP	Potential Collision Point
RAN	Raytheon Anschütz

Term	Description
RMA	Recommended Minimum Navigation Information
RMC	Recommended Minimum Navigation Information
ROT	Rate Of Turn
SOG	Speed Over Ground
SOLAS	Safety Of Life At Sea
STBY	Stand by
STW	Speed True Water
TCPA	Time of Closest Point of Approach
UPS	Uninterruptible Power Supply
UTC	Universal Time Coordinated
VBW	Dual Ground/Water Speed
VDE	Verband der Elektrotechnik Elektronik Informationstechnik e. V.
VDR	Voyage Data Recorder
VHW	Water speed and heading
VRM	Variable Range Marker
VTG	Track made good and Ground speed
WMM	World Magnetic Model
WT	Water Track
ZDA	Time & Date - UTC, day, month, year and local time zone

1 System Description

1.1 General Infomation

The SYNAPSIS Bridge Integrated Platform (BIP) provides data management and data distribution functionality for the SYNAPSIS INS as well as the SYNAPSIS stand-alone systems Radar, ECDIS, ECDIS 24 and Nautoconning. The overall functionality of the BIP is depicted in Figure 1-1.

The SYNAPSIS INS thus handles the nautical functions **Route Planning**, **Route Monitoring**, **Collision Avoidance**, **Navigation Control Data**, **Status and Data Display**, **Central Alert Management** and **Track Control** in accordance with the INS performance standard.

A multifunction console (MFC) on which an ECDIS is installed can be used as a task station for **Route Planning** and **Route Monitoring**.

If the radar application is installed, the MFC can be used as a task station for **Collision Avoidance**.

An installed Nautoconning system provides the tasks **Navigation Control Data**, **Status** and **Data Display** and **Central Alert Management**.

An ECDIS and an Autopilot are required for execution of Track Control.

An INS bridge system essentially comprises the multifunction consoles (MFC) and the Autopilot. The computers of the multifunction consoles are generally equipped and supplied with the software for the applications for Radar, ECDIS and Nautoconning and the SYNAPSIS Bridge Integration Platform. Multifunction consoles are connected to a system wide redundant network (LAN).

In addition to interfacing of the sensors (Gyro, GPS, AIS, etc.), the INS bridge system also provides an interface to the Bridge Navigational Watch Alarm System BNWAS (ALERT ESCALATION).

The configuration of the SYNAPSIS INS can be performed or modified from any multifunction console within the bridge system. After confirmation, changes are transmitted to all the MFCs via the network (LAN) and are after a restart of the system effective.

The SYNAPSIS INS includes a Consistent Common Reference System (CCRS). This system evaluates the sensor data applying qualifying criteria and provides analysed data to all components. On request, the CCRS automatically selects the best sensors (see section 2).

The SYNAPSIS INS includes an Integrated Target Management (ITM). This management evaluates the tracked targets and AIS acquired from the Radar equipment in the system. In this case a central target association, calculation, evaluation and alerting take place. The user benefit is a redundantly target apparition on an avoidance display and a redundantly alarm handling.

The overarching Alert System displays in a unified and harmonized way, navigational and system alarms and messages simultaneously on all MFCs.

The system monitor of the SYNAPSIS INS monitors the components of the System and the interfaced sensors.

INS specific
SYNAPSIS INS information pages (SENSOR SELECTION, AIS HISTORY, CENTRAL ALERT MANAGEMENT, ALERT HISTORY, NAVTEX HISTORY, SYSTEM STATUS) are provided within the Nautoconning application.

Within the ECDIS application, the SENSOR SELECTION information page is provided for the sensor selection.
A system wide dimming and color scheme changeover is possible at any time at any MFC.

A service tool integrated into the SYNAPSIS INS allows centralized input of ship-specific parameters, the adaption of all interfaced sensors and the read-out of log and system error messages. Access to the service tool is protected by a password and should only be allowed to trained personnel.

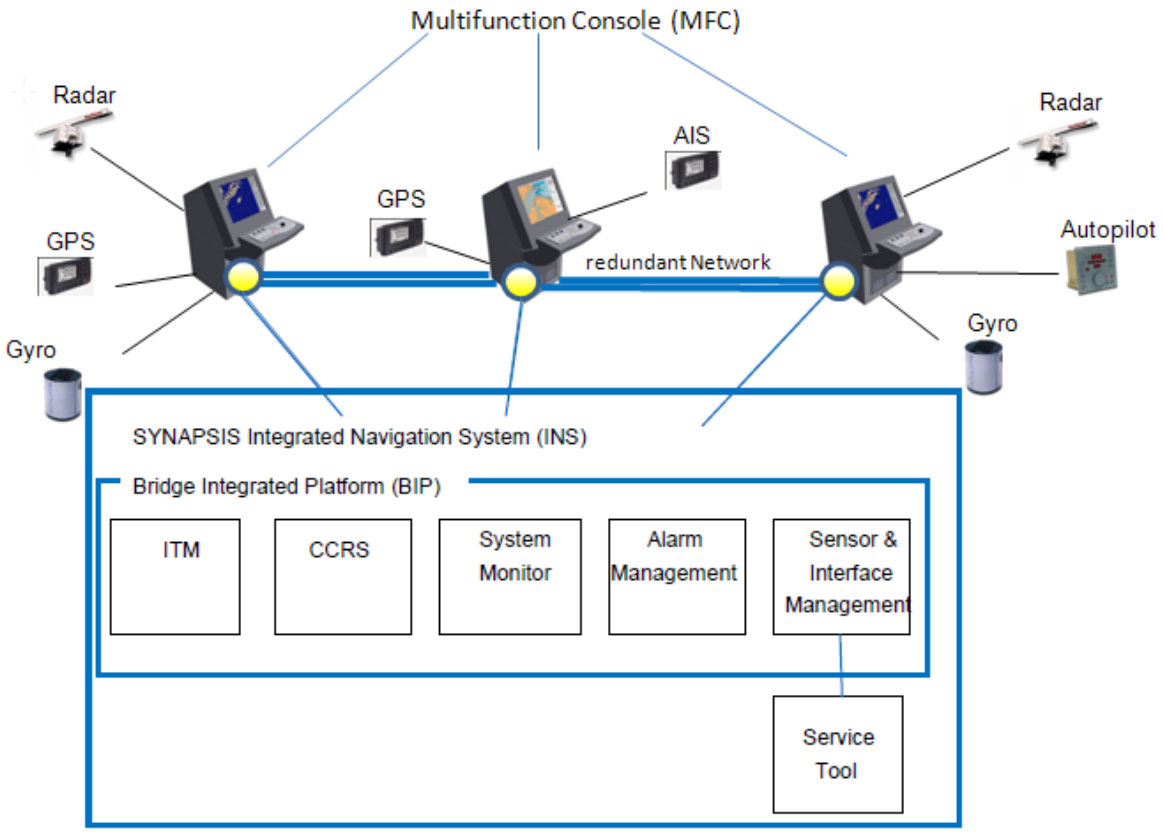


Figure 1-1 SYNAPSIS Block Diagram

1.2 SYNAPSIS System Architecture

1.2.1 SYNAPSIS System Architecture under BoxPC conditions

In the case of Radar Stand-alone Consoles, no ECDIS and Nautoconning software is installed. In the same way Stand-alone ECDIS Consoles do not offer Radar or Nautoconning Software. On a Nautoconning Stand-Alone Console no ECDIS and Radar software is installed.

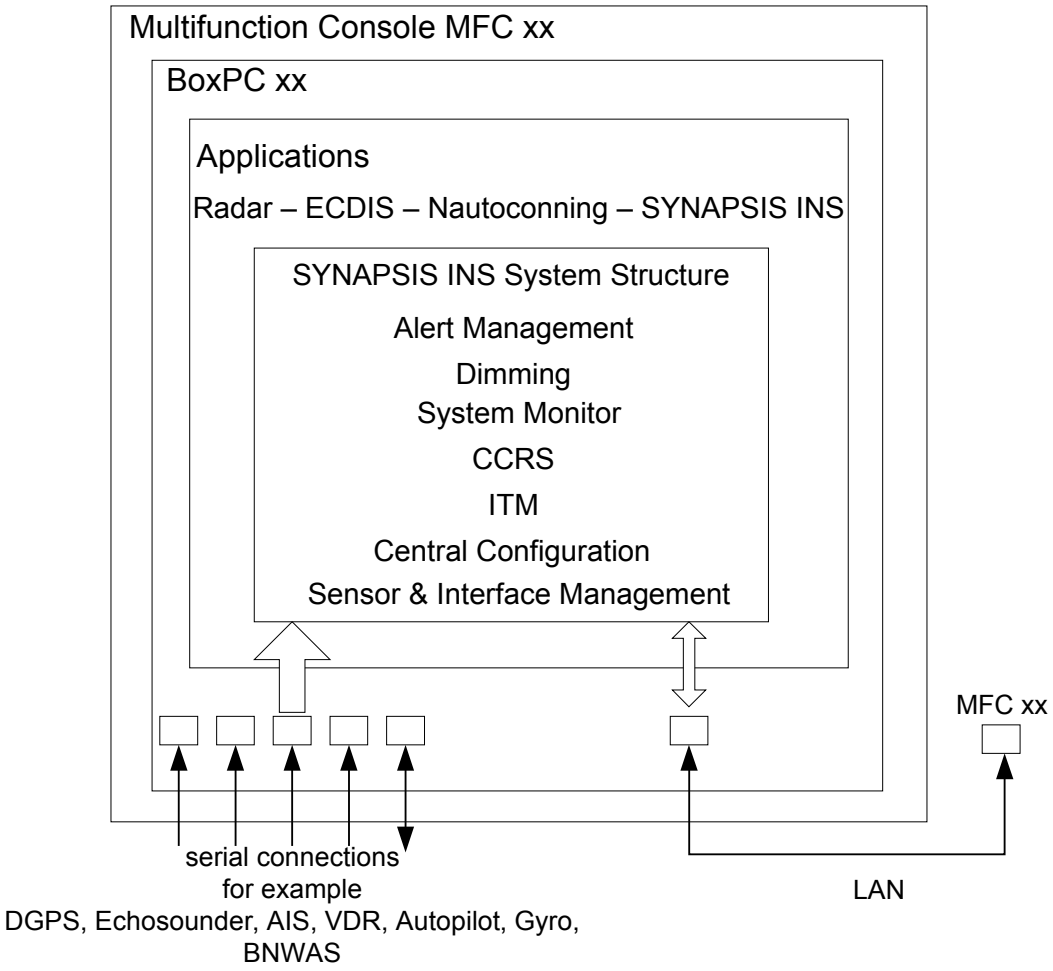


Figure 1-2 SYNAPSIS System architecture under BoxPc conditions

1.2.2 SYNAPSIS System Architecture under Small Marine Computer conditions

In the case of Radar Stand-alone Consoles, no ECDIS and Nautoconning software is installed. In the same way Stand-alone ECDIS Consoles do not offer Radar or Nautoconning Software. On a Nautoconning Stand-Alone Console no ECDIS and Radar software is installed.

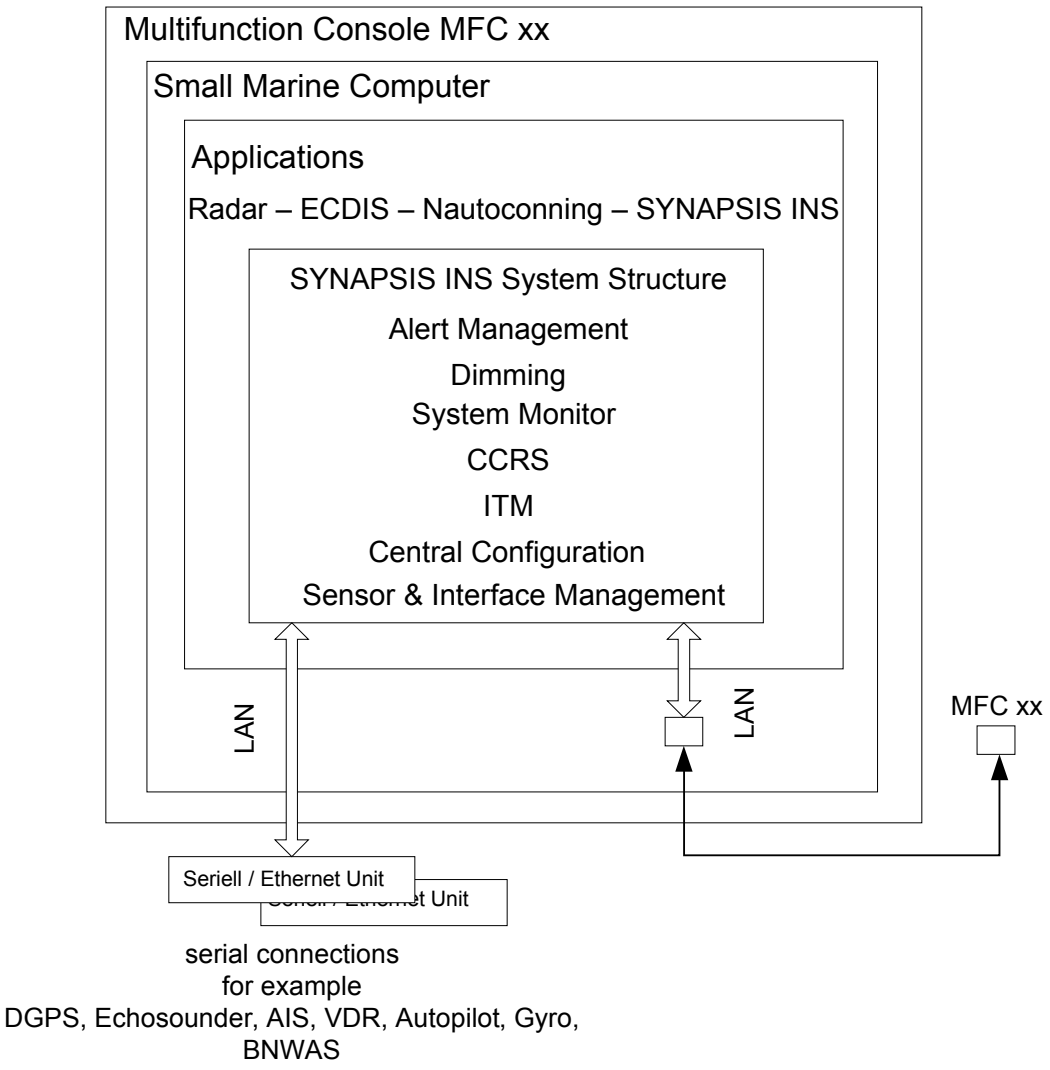


Figure 1-3 SYNAPSIS System architecture under Small Marine Computer conditions

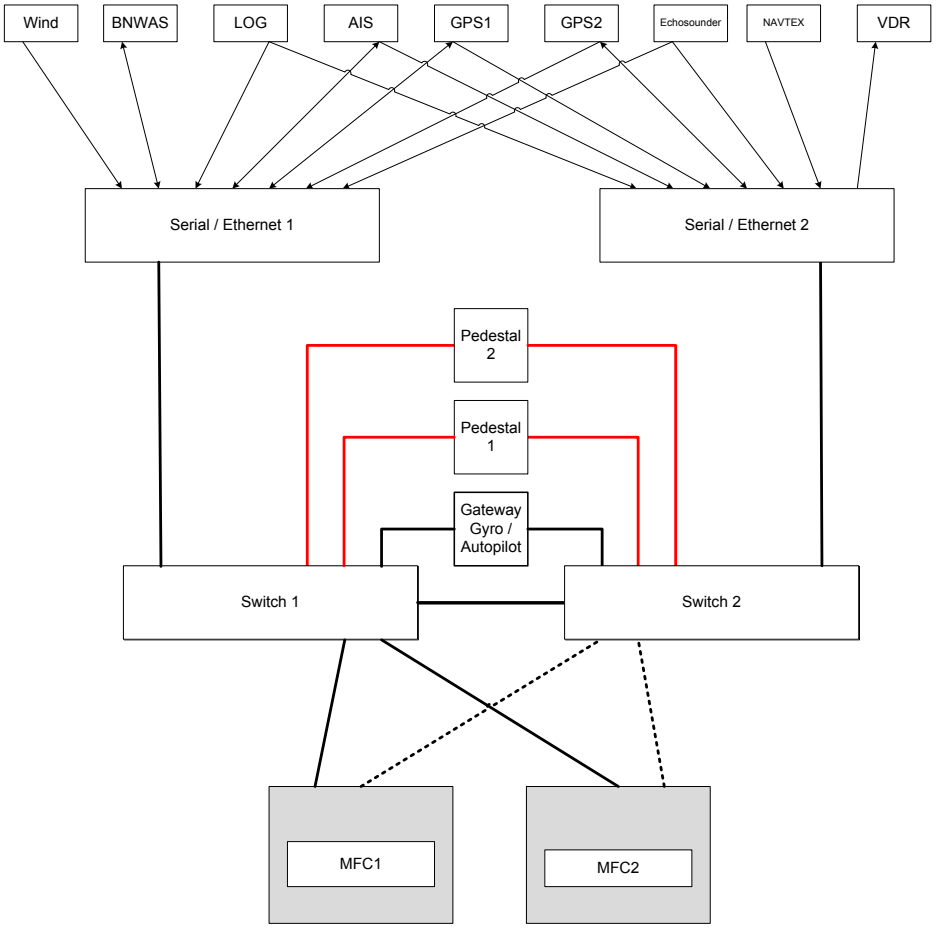


Figure 1-4 Sensor & Interface Management Small Marine Computer (LAN)

1.3 SYNAPSIS INS System Structure

1.3.1 Sensor & Interface Management with BoxPc (serial)

The sensors are connected via the serial interfaces of the BoxPC. Each BoxPC has 10 serial interfaces. It makes no difference to which MFC a sensor is connected after installation; it is available for all applications on all MFCs via LAN.

The Sensor & Interface Management reads the sensor data within the MFC network and forwards the data to the CCRS.

The network connection is established via 2 Ethernet interfaces provided on each BoxPC.

1.3.2 Sensor & Interface Management with Small Marine Computer (LAN)

The Sensor & Interface Management is designed as a redundant network system.

The sensors are connected with the redundant Serial / Ethernet Units. The Ethernet output signal from the Serial / Ethernet Unit is transferred via LAN connection to the redundant Ethernet Switches. The Small Marine Computer and the X/S Band Pedestal with Transceiver are connected via LAN connection to the Ethernet Switches (see Figure 1-4).

The Sensor & Interface Management reads the sensor data within the network and forwards the data to the CCRS in the Small Marine Computer.

1.3.3 Central Configuration

The Central Configuration is set up during the initial installation of the bridge system via the SYNAPSIS Service Tool. During this process, the interfaced sensors are configured and ship-specific parameters (length, width, height), the locations of the antennae and the devices are entered and saved.

This information is stored redundantly as central configuration on all MFCs and is required for the data transfer between the Sensor & Interface Management, the CCRS and the applications

1.3.4 Integrated Target Management (ITM)

In an INS system all collision avoidance displays are equipped with their own target tracker (sensor-level targets). The centralized target management reads in the tracked target information and accumulates joint target or ais information with following focuses;

- Performs target association (ARPA/AIS, ARPA/ARPA) between sensor-level targets to create a list of system-level targets without duplicates.
- Calculates derived data (CPA/TCPA, BCR/BCT, true speed and course).

- Evaluates target data against thresholds (CPA/TCPA limit, guard zone).
- Generates targets-related alerts (new target, lost target, CPA/TCPA violation, guard zone) based on system-level targets.
- Sends system-level targets to Collision Avoidance and Route Monitoring display together with all target-related data for immediate situation assessment. Target-related alerts (cat. A) are acknowledgeable at every Collision Avoidance (Radar) and Route Monitoring (ECDIS) display

Collision Avoidance and Route Monitoring displays provide means to set target management parameters (e.g. threshold, labels, association priorities, zones, …).
If provided, information from tender tracking system is incorporated into the integrated target management.

1.3.5 Consistent Common Reference System (CCRS)

The Consistent Common Reference System performs a qualitative evaluation of all sensor data. The sensor data is displayed on the SENSOR SELECTION page (*in the Nautoconning application, if available*). A color scaling scheme rates the quality of the sensor data.

If a sensor failure is registered within the INS, the CCRS immediately initiates an automatic changeover to a backup sensor and generates an associated alert

1.3.6 System Monitor

The system monitor monitors all applications of the MFCs, the hardware (BoxPC) and the external devices interfaced to the INS.

The status of all interfaced devices is continuously monitored (ON or OFF). Devices providing an NMEA alert interface (ALR or ALC/ALF telegram format) generate additional error or fault messages. This information is read in via the alert system and displayed at the CENTRAL ALERT management HMI.

The system monitor provides simple monitoring of the network. It checks continuously whether an MFC can be reached via the network. Error and status messages of the network switches are not evaluated

1.3.7 Dimming

All MFCs of a bridge system support a synchronized system wide changeover of the color schemes in addition to the common brightness dimming.
For dimming and change of color scheme, the MFCs are split into groups using the service tool during the initial installation. The changeover of the color scheme at an MFC or the setting of the global dimming value always applies to all the MFCs belonging to the same group.

Furthermore, each MFC can be adjusted individually according to the light conditions without influencing other MFCs.

The change of color schemes is provided when using Radar, ECDIS or Nautoconning

1.3.8 Alert Management

The central alert management handles all the alarms generated within the INS, e.g. by Radar, ECDIS, the CCRS or the Autopilot. In addition, the alert management reads in all alarms, warnings or messages from the interfaced devices having an NMEA data interface (ALR or ALC/ALF telegram format).

Alerts are classified according to their urgency as required by IEC 61924-2. Depending on urgency alarms, warnings or messages are then generated within the bridge system together with an acoustic announcement.

At the Nautoconning application, the information pages CAM and ALERT HISTORY provide a complete overview of the alert situation within the system.

The central alert management classifies the alarms and warnings into categories A, B and C in accordance with the performance standard.

Category A Alarms
Category A alarms can only be acknowledged at the application where they are generated; e.g. Radar, ECDIS, or Autopilot.

Target related Alerts (e.g. CPA/TCPS) can be acknowledged on any Radar and ECDIS MFC display in a INS system.

Category B Alarms
Category B alarms can be acknowledged at the application (such as Radar, ECDIS, or Autopilot) and at the central alert HMI of the Nautoconning.

Category C Alerts
The central alert management is able to display category C alerts reported by external systems via ALC/ALF sentences.

As required by the bridge alert management performance standards, category C alerts cannot be acknowledged at the bridge. For example, certain alerts from the engine may be reported as category C alerts.

1.3.8.1 MUTE Function *(INS and Nautoconning specific)*

The alarm displays of the Nautoconning information pages each have a MUTE soft button. After this button has been pressed, all alarms and warnings are muted for 30 seconds.

1.3.8.2 ALERT ESCALATION (BNWAS)

An ALERT ESCALATION situation can only be taken into consideration if a BRIDGE NAVIGATION WATCH ALARM SYSTEM (BNWAS) is part of the INS.

The user is hereby forced to acknowledge an alarm within a given time window (e.g. 60 seconds). If this time window is exceeded, an EMERGENCY CALL is triggered. The time window is set via the service tool.

The following procedure applies for the handling of warnings. A warning that is not acknowledged is declared as an alarm after 60 seconds. If this alarm is also not acknowledged within further 60 seconds, an EMERGENCY CALL is triggered.

Apart from the alert escalation, the SYNAPSIS INS also supports the resetting of the BNWAS watch alarm by expedient operations in the Radar. If the navigator works with the Radar, the watch alarm of the BNWAS is reset.

The expedient operation must take place at a console from which the user has the ship and its surroundings in his sights (PROPER LOOKOUT).

These operation-related characteristics of the Radar application are allocated to the corresponding consoles via the SYNAPSIS service tool.

2 Operation

2.1 General Information on Operation *(INS specific)*

There is no direct operation for the SYNAPSIS INS. All system-relevant information is displayed on the information pages of the NAUTOCONNING application. These SYNAPSIS INS-specific information pages are described in the following sections; for further information, see NAUTOCONNING documentation.

The SYNAPSIS INS Service Tool is described in the manual Doc. No. 4169.

2.2 CENTRAL ALERT MANAGEMENT (CAM HMI)

The Central Alert Management reads in all navigational and system alarms, warnings and messages and displays them.

At least 20 alerts can be displayed at once. Additional alerts can be displayed by scrolling-down the list.

Displayed information includes the status and alarm category, the cause, an information text and the date and time of recording.

Alarms and warnings are classified and tagged in three categories.

Category **A**
Alarms and warnings of this category must be acknowledged at the MFC application referred to in the table of the CAM HMI.

Category **B**
Alarms and warnings of this category can be acknowledged at any application and at the CAM HMI.

Active or unacknowledged alarms are always handled with the highest priority and displayed in order of their priority.

Category **C**
Category C Alarms and warning of this category cannot be acknowledged on the bridge, e.g., certain alerts from the engine.

ALARM
Alarms need immediate attention of the operator.

The most recent alarm is always displayed in the top line of the list.

- The alarm text is displayed in RED.
- Unacknowledged alarms are flashing.
- An acoustic signal is released with the alarm.

An Alarm must be acknowledged according to category **A** or **B** as assigned to it.
Category **C** alerts cannot be acknowledged on the bridge.

WARNING
Warnings are not immediately dangerous, but may become so.

As long as there is no active or unacknowledged alarm, a current warning is displayed in the top line of the list in ORANGE.

- The warning text is displayed in ORANGE.
- Unacknowledged warnings are flashing.
- An acoustic signal is released with the warning.

A Warning must be acknowledged according to category **A** or **B**.
Category **C** alerts cannot be acknowledged on the bridge.

CAUTION
A caution message is always placed after the alarm or warning entries in the displayed list. Caution messages are displayed in GRAY.

Caution messages are also displayed as GRAY text on the alarm displays of the applications Radar and ECDIS.

2.2.1 CENTRAL ALERT MANAGEMENT (HMI) Display *(INS specific)*

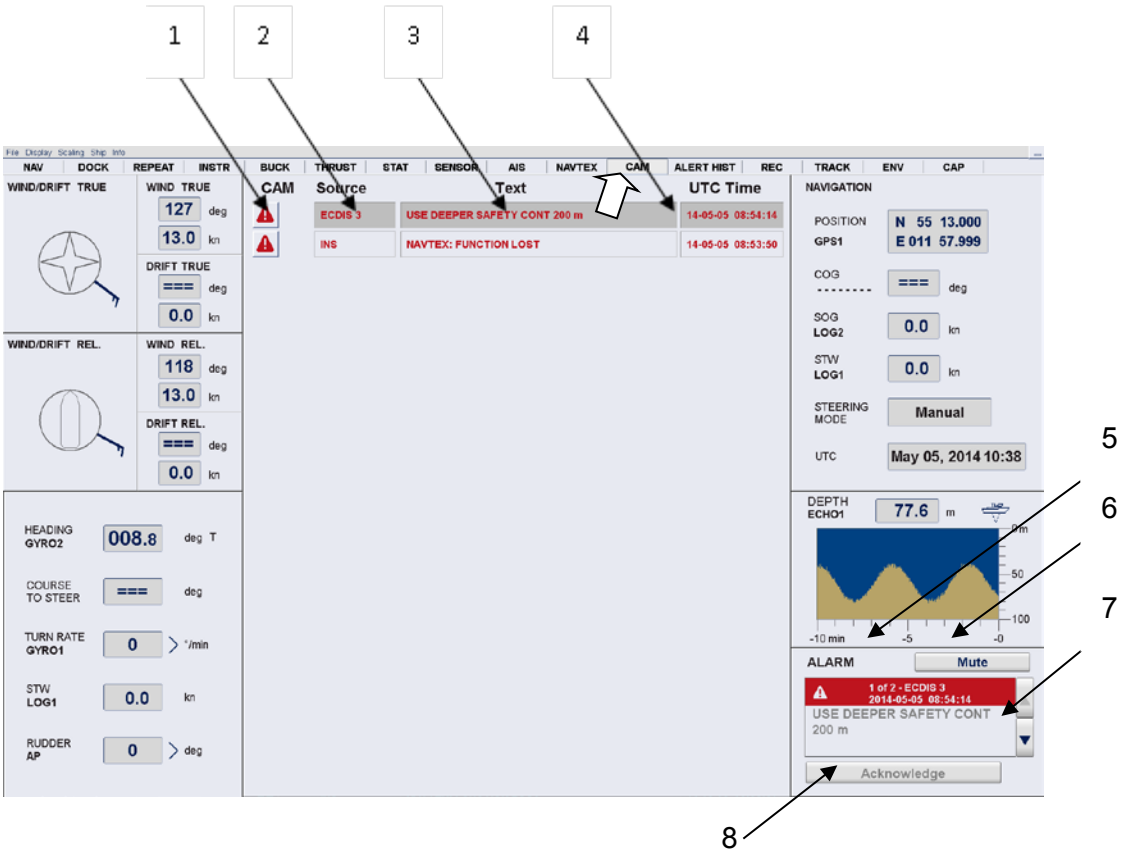


Figure 2-1 Central Alert Management

Pos.	Information
1	Status display CAM; alarm, warning or caution still active. Status display CAM; alarm, warning or caution message already acknowledged (GRAY).
2	Source (Radar, ECDIS, CCRS).
3	Text message.
4	UTC Time with date and time.
5	Display for alarms, warnings and caution messages.
6	Soft button MUTE: When the button is pressed, all alarms and warnings are muted for 30 seconds.

Pos.	Information
7	Soft button (up/down): Selection of an item from the display.
8	Soft button: Acknowledge.

Categories

Category **A** and **C**

This alarm (RED) or warning (ORANGE) can only be acknowledged via the MFC providing the corresponding application which triggered the alarm or warning.

The text of category A and C alerts is marked with the following symbols:

Alarm (red)

Acknowledge not allowed for alarm (flashing, acknowledged no).

Acknowledge this alarm at the MFC where it has been generated.

Warning (orange)

Acknowledge not allowed for warning (flashing, acknowledged no).

Acknowledge this warning at the MFC where it has been generated.

Alert Status

This alarms (RED), warning (ORANGE) or caution (YELLOW) can be acknowledged at any MFC where the alarm has been launched or at the CAM HMI.

Alarm (red)

Active – unacknowledged alarm (flashing)

Active – silenced alarm (flashing)

 Active- acknowledged alarm

 Rectified – unacknowledged alarm (flashing)

 Active – responsibility transferred alarm

Warning (orange)

 Active - unacknowleged warning (flashing)

 Active – silenced warning (flashing)

 Active – acknowledged warning

 Rectified – unacknowledged warning (flashing)

 Active – responsibility transferred warning

Caution (yellow)

 Caution

2.3 ALERT HISTORY *(INS specific)*

At the alert history page all alarms, warnings and caution messages are stored continuously for 24 hours.

The time of occurrence, the time of acknowledgement and the time of remedying are displayed for each alert.

At this information page, different filter properties can be set via soft button functions.

The filter properties are not affected by changing to a different information page. All filter properties are reset on quitting the Nautoconning application.

2.3.1 ALERT HISTORY Information Page

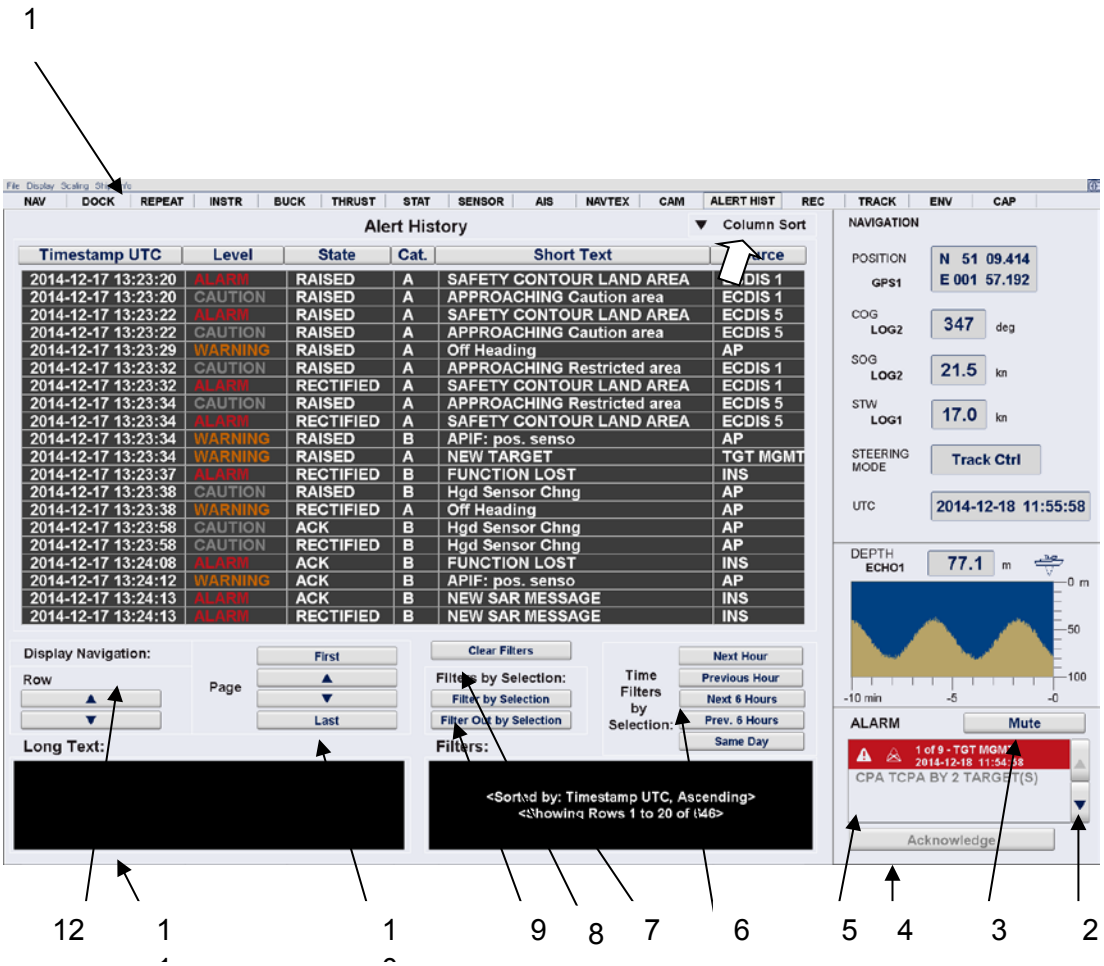


Figure 2-2 Alert History Information

Pos.	Information
1	Column selection buttons (Timestamp UTC, Level, State, Short Text and Source). Pressing a selection button allows the data sorting within the columns to be changed to ascending or descending form. This sorting criterion is shown in the Filter display (Pos.7).
2	Soft button (up/down): Selection of an alert
3	Soft button MUTE: When the button is pressed, all alarms and warnings are muted for 30 seconds.
4	Soft button: Acknowledge
5	Display for alarms, warnings and caution messages.
6	Time filter selection. Pressing a soft button displays the alert history for the desired period of time window.
7	The current filter properties are shown in plain text in the filter display.
8	Clear filters. Pressing the soft button cancels all the filter properties.
9	Filters by selection. Within this function, the filter criterion can be selected using the trackball-guided cursor. **Action** Position the cursor e.g. on a **State** field (ACTIVE). Double-clicking with the left trackball button selects the field (orange background color). Pressing the soft button *Filter by selection* displays only the events which are still ACTIVE. Pressing the soft button *Filter Out by Sel.* displays no ACTIVE events.
10	Page allows a page change within the alert history.
11	The system messages (short text) are displayed in more detail in the long text display.
12	Pressing the selection soft button allows the content of the alert history page to be changed line wise in ascending or descending order.

2.4 AIS MESSAGE HISTORY *(INS specific)*

Within the AIS Message History, all AIS information is stored. Within this information page, different filter properties can be set via soft button functions.

The filter properties are not affected by changing to a different information page. All filter properties are reset on quitting the Nautoconning application.

2.4.1 AIS MESSAGE HISTORY Information Page

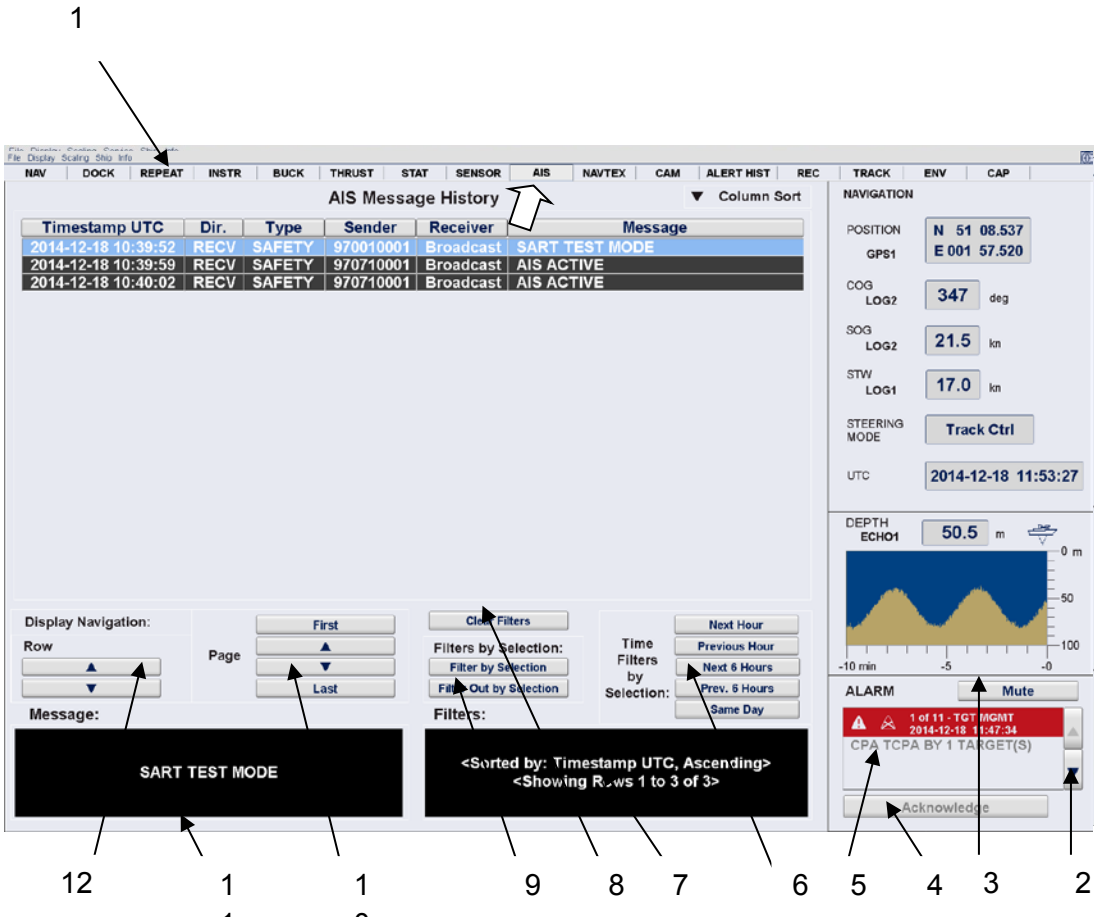


Figure 2-3 AIS Message History

Pos.	Information
1	Column sort button (Timestamp UTC, Dir., Type, Sender, Source, Receiver and Message). Pressing a selection button allows the data sorting within the columns to be changed to ascending or descending form. This sorting criterion is shown in the filter display (Pos.7).
2	Soft button (up/down): Selection of an alert.
3	Soft button MUTE: When the button is pressed, all alarms and warnings are muted for 30 seconds.
4	Soft button: Acknowledge.
5	Display for alarms, warnings and caution messages.
6	Time filters by selection. Pressing a soft button displays the AIS Message History in the desired time window.
7	The current filter properties are shown in plain text in the filter display.
8	Clear filters. Pressing the soft button cancels all the filter settings.
9	Filters by selection. Within this function, the filter criterion can be selected using the trackball-guided cursor. **Action** Position the cursor e.g. on a **Type** field (BIN). Double-clicking with the left trackball button selects the field (orange background color). Pressing the soft button *Filter by selection* displays only the BIN events. Pressing the soft button *Filter Out by Sel.* displays no BIN events.
10	Page allows a page change within the AIS Message History.
11	The system messages (body text) are displayed in more detail in the long text display. Depending on the length of the text, a scroll bar appears to the right of the display with which the complete content of the text can be scrolled up or down.
12	Pressing the selection soft button allows the content of the AIS Message History page to be changed line wise in ascending or descending order.

2.5 NAVTEX MESSAGE HISTORY *(INS specific)*

Within the NAVTEX Message History, all NAVTEXT information is stored. Within this information page, different filter properties can be set via soft button functions.

The filter properties are not affected by changing to a different information page. All filter properties are reset on quitting the Nautoconning application.

2.5.1 NAVTEX MESSAGE HISTORY Information Page

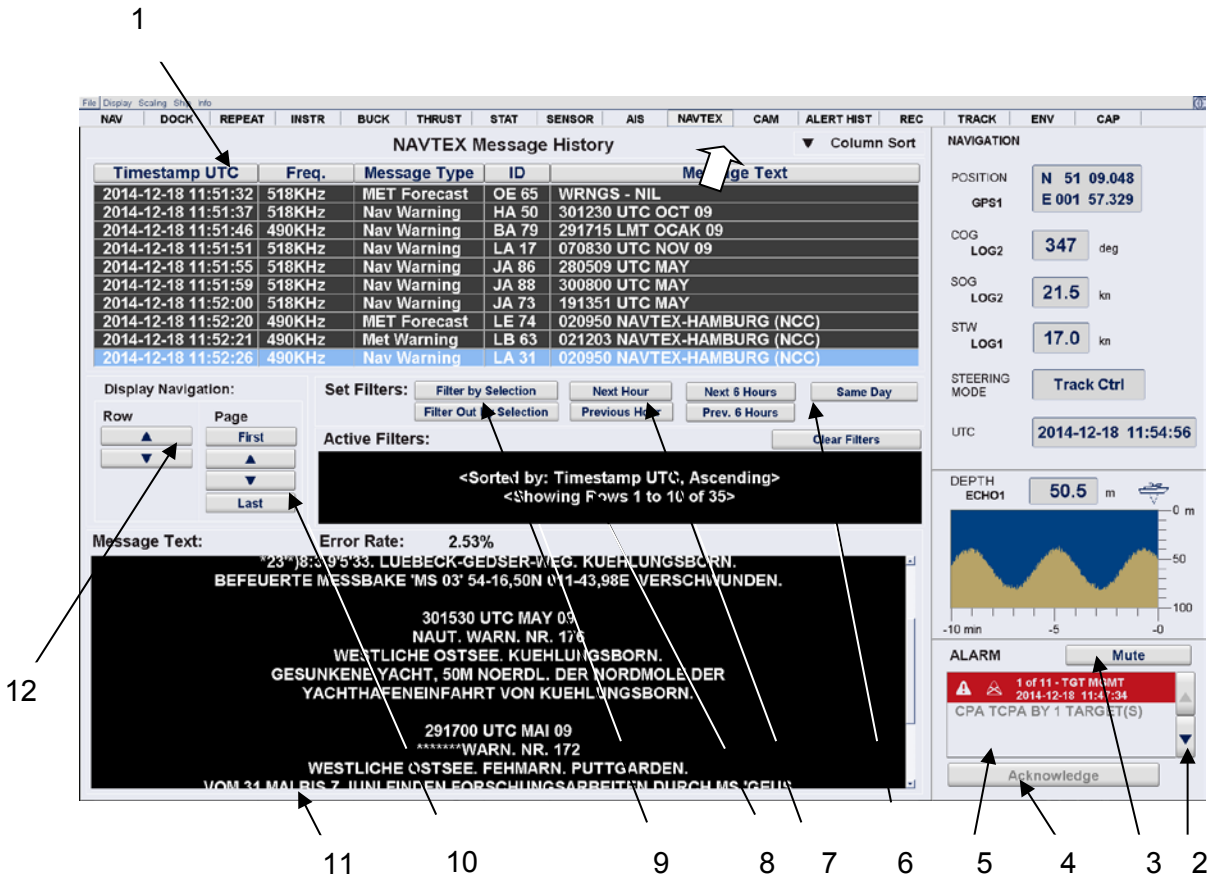


Figure 2-4 NAVTEX Message History

Pos.	Information
1	Column sort button (Timestamp UTC, Freq., Message Type, ID and Message Text). Pressing a selection button allows the data sorting within the columns to be changed to ascending or descending form. This sorting criterion is shown in the filter display (Pos. 8).
2	Soft button (up/down): Selection of an alert.
3	Soft button MUTE: When the button is pressed, all alarms and warnings are muted for 30 seconds.
4	Soft button: Acknowledge
5	Display for alarms, warnings and caution messages.
6	Clear filters. Pressing the soft button cancels all the filter settings.
7	Pressing a soft button displays the NAVTEX Message History in the desired time window.
8	The current filter properties are shown in plain text in the filter display.
9	Filters by selection. Within this function, the filter criterion can be selected using the trackball-guided cursor. **Action** Position the cursor e.g. on a **Message Type** field (met warning). Double-clicking with the left trackball button selects the field (orange background color). Pressing the soft button *Filter by selection* displays only the BIN events. Pressing the soft button *Filter Out by Sel.* displays no BIN events.
10	Page allows a page change within the NAVTEX Message History.
11	The system messages (body text) are displayed in more detail in the long text display. Depending on the length of the text, a scroll bar appears to the right of the display with which the complete content of the text can be scrolled up or down. Error Rate: Error rate displays the error rate of the NAVTEX message. Within the NAVTEX transmission, special characters, parts of sentence of complete lines can be lost due to transmission errors. These missing parts of the sentence are replaced with substitute characters (e.g. **).

Pos.	Information
12	Pressing the selection soft button allows the content of the NAVTEX Message History page to be changed line wise in ascending or descending order.

2.6 SENSOR SELECTION *(INS, ECDIS, Radar specific)*

All the sensors which are connected to the SYNAPSIS INS and have been configured are displayed on the Sensor Selection page.

The CCRS selection of the sensors can be performed automatically or manually. The CCRS continuously monitors the quality of the sensor information and assigns colored quality indicators.

Quality Indicator (IEC 62288 edition 1)	Quality Indicator (IEC 62288 edition 2)	Description
(green)	(green)	The sensor has good integrity (edition 1 conditions **GREEN**). The sensor has good integrity (edition 2 conditions **GREEN**).
(orange)	(yellow)	The sensor has doubtful integrity. Data from this sensor can be used carefully, but not for automatic control functions (edition 1 conditions **ORANGE**). The sensor has doubtful integrity. Data from this sensor can be used carefully, but not for automatic control functions (edition 2 conditions **YELLOW**). If there is only one source for a certain type of data, this source has doubtful integrity. In this case, doubtful integrity is not a marker for an error.
(red)	(yellow)	The sensor failed the integrity test (edition 1 conditions **RED**). The sensor failed the integrity test (edition 2 conditions **YELLOW**).
(red)	(orange)	No valid and plausible data available from the sensor (edition 1 conditions **RED** and for edition 2 conditions orange).

In automatic sensor selection (AUTO) the CCRS uses the sensor with the best result of the integrity check as a source for the system level data. If there are multiple “best” sensors the sensor with the higher priority (according to the configured degradation path) is used.

The user can exclude sensors from automatic sensor selection. If a sensor is excluded, the sensor is not selected even if this sensor has the best quality rating.

In manual sensor selection mode (MAN), the user selects the source sensor for the system level data. As long as the sensor delivers data, this data is used. If the sensor does not deliver data, the CCRS switches to the next sensor in the configured degradation path. If the best sensor recovers, the CCRS switches back to the selected sensor. If the user did not choose the best sensor according to the sensor rating of the CCRS, a “BETTER SENSOR AVAILABLE” caution is generated.

2.6.1 SENSOR SELECTION

INS specific

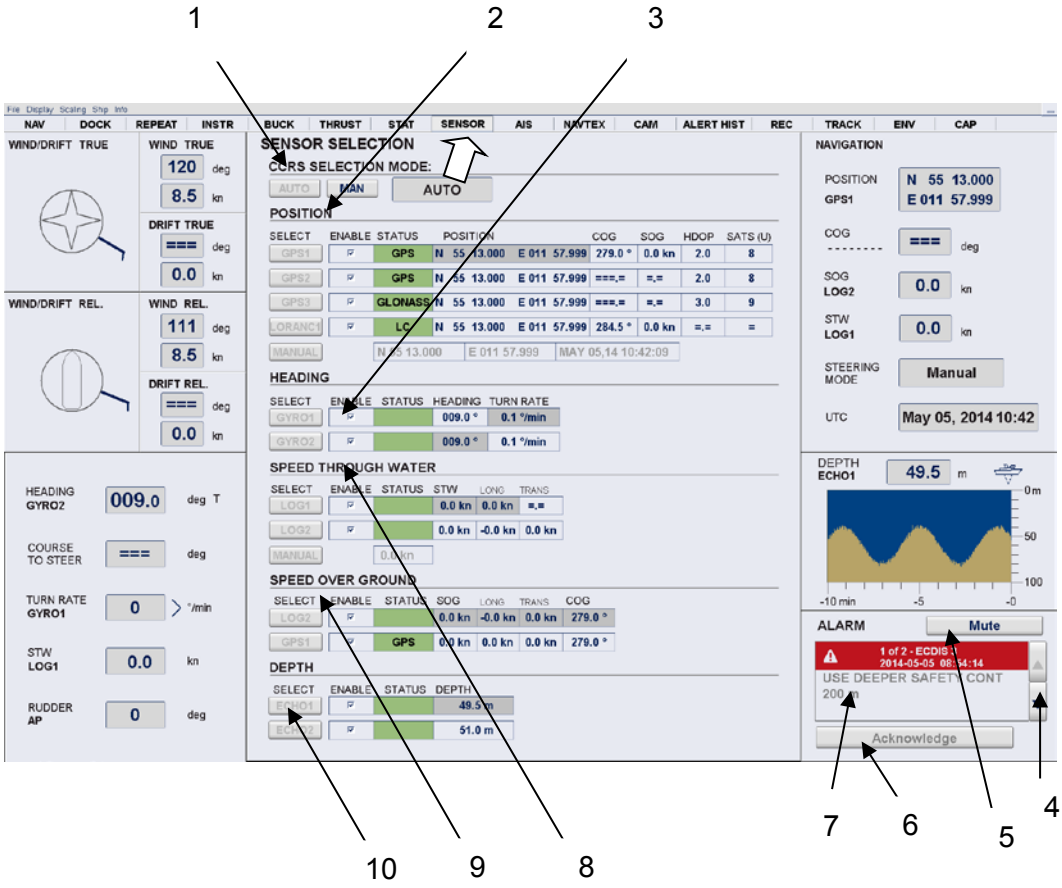


Figure 2-5 INS Sensor Selection Page

ECDIS specific

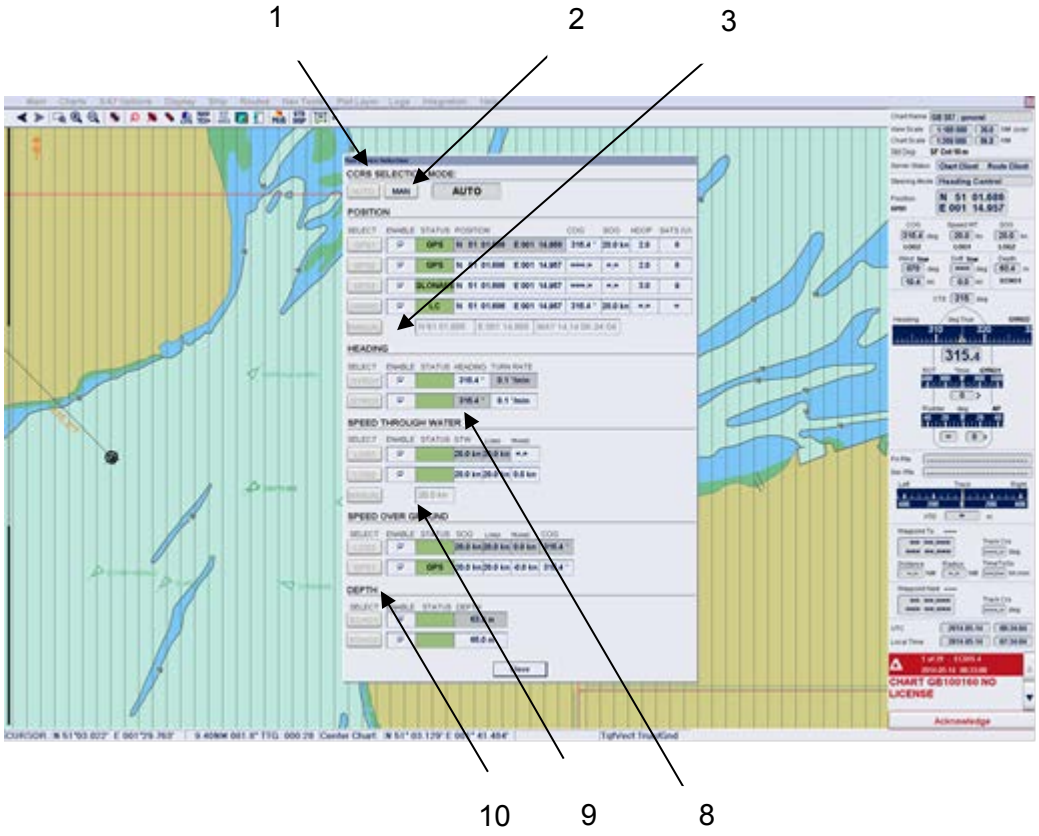
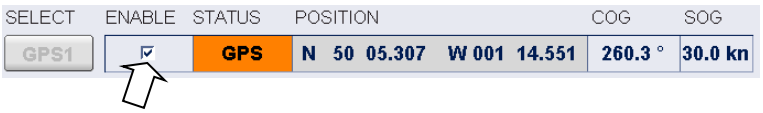
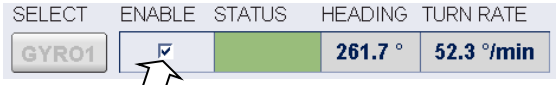
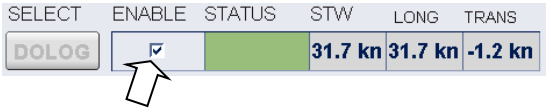
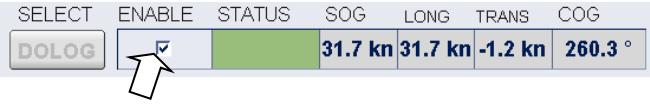
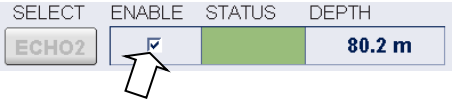


Figure 2-6 ECDIS Nav Device Selection

Pos.	Information
1	CCRS SELECTION MODE. Within this selection possibility, the type of sensor selection is selected.  AUTO for the automatic sensor selection. The designation of the sensor soft buttons is displayed in GRAY. GRAY means cannot be selected because active. The status display shows the selected mode AUTO. MAN for manual sensor selection. The designation of the sensor soft buttons is displayed in BLACK. BLACK means selectable. The status display shows the selected mode MAN.
2	POSITION All sensors which can be used within SYNAPSIS INS are displayed at the position display.  The SELECT soft buttons are available only in MAN mode. ENABLE selection is available in AUTO mode and MAN mode. ENABLE means that the sensor information has been included in the CCRS rating. DISABLE means that the sensor information has been included in the CCRS rating. However this sensor information is not forwarded as active information to the down line applications Radar and ECDIS. The quality indicator (GREEN, ORANGE, RED or YELLOW) is always displayed within the STATUS display. The additional entry of the device designation depends on the content of the data telegram received. In case of failure of the position sensors the MANUAL select function is enabled. In case of the failure of all position sensors, the last valid position is transferred to the MANUAL field and declared as the valid position. *The valid position information must be from the last hour. In this case the system calculation considered the actual heading and speed and this position information. Older position information will be not accepted from the system.* Within this field, position corrections can be made via an on-screen keyboard.

Pos.	Information
	The entered position serves as the anchor position for the dead reckoning.  **Action** Position the trackball-guided cursor on e.g. 1st field and press the left trackball button. The online keyboard appears the system is operated via the trackball-guided cursor. The input must be terminated with the ENTER key. The online keyboard disappears.
3	HEADING All sensors which can be used within SYNAPSIS INS are displayed at the heading display.  The SELECT soft buttons are available only in MAN mode. ENABLE selection is available in AUTO mode and MAN mode. ENABLE means that the sensor information has been included in the CCRS rating. DISABLE means that the sensor information has been included in the CCRS rating. However this sensor information is not forwarded as active information to the down line applications Radar and ECDIS. The quality indicator (GREEN, ORANGE, RED or YELLOW) is always displayed within the STATUS display. The additional entry of the device designation depends on the content of the data telegram received.
4	Soft button (up/down): Selection of an item from the display.
5	Soft button MUTE: When the button is pressed, all alarms and warnings are muted for 30 seconds.
6	Soft button: Acknowledge.
7	Display for alarms, warnings and caution messages.

Pos.	Information
8	SPEED THROUGH WATER All sensors which can be used within SYNAPSIS INS are displayed within the SPEED THROUGH WATER display.  The SELECT soft buttons are available only in MAN mode. ENABLE selection is available in AUTO mode and MAN mode. ENABLE means that the sensor information has been included in the CCRS rating. DISABLE means that the sensor information has been included in the CCRS rating. However this sensor information is not forwarded as active information to the down line applications Radar and ECDIS. The quality indicator (GREEN, ORANGE, RED or YELLOW) is always displayed within the STATUS display. The additional entry of the device designation depends on the content of the data telegram received. Failure of the speed sensors. In case of the MANUAL select function is enabled. After the failure of all speed sensors, the last valid speed through water (STW) information is transferred to the MANUAL field and declared as the valid STW. Within this field, speed corrections can be made via an on-screen keyboard.  **Action** Position the trackball-guided cursor in the field and press the left trackball button. The online keyboard appears, the system is operated via the trackball-guided cursor. The input must be terminated with the ENTER key. The online keyboard then disappears.
9	SPEED OVER GROUND All sensors which can be used within SYNAPSIS INS are displayed within the

Pos.	Information
	SPEED OVER GROUND display.  The SELECT soft buttons are available only in MAN mode. ENABLE selection is available in AUTO mode and MAN mode. ENABLE means that the sensor information has been included in the CCRS rating. DISABLE means that the sensor information has been included in the CCRS rating. However this sensor information is not, however, forwarded as active information to the down line applications Radar and ECDIS. The quality indicator (GREEN, ORANGE, RED or YELLOW) is always displayed within the STATUS display. The additional entry of the device designation depends on the content of the data telegram received.
10	DEPTH All sensors which can be used within SYNAPSIS INS are displayed at the DEPTH display.  The SELECT soft buttons are available only in MAN mode. The ENABLE selection is available in AUTO mode and MAN mode. ENABLE means that the sensor information has been included in the CCRS rating. DISABLE means that the sensor information has been included in the CCRS rating. However this sensor information is not forwarded as active information to the down line applications Radar and ECDIS. The quality indicator (GREEN, ORANGE, RED or YELLOW)) is always displayed within the STATUS display. The additional entry of the device designation depends on the content of the data telegram received.

Radar specific

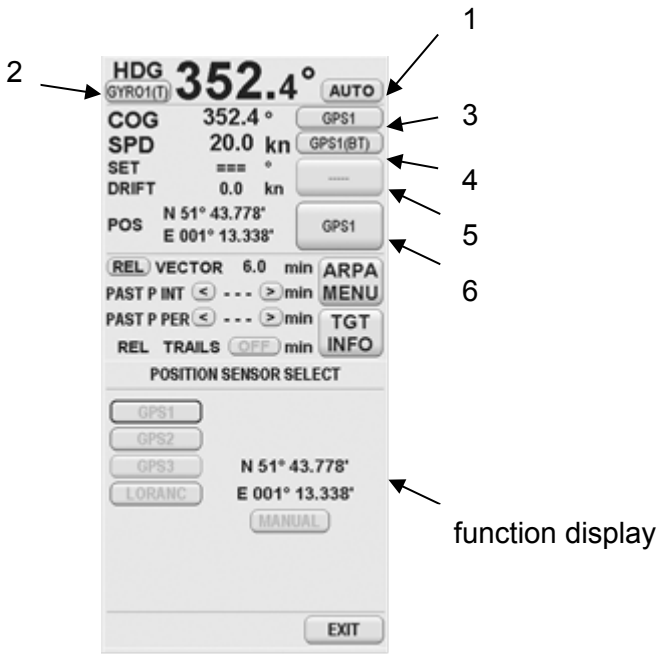
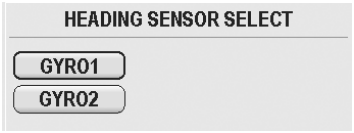
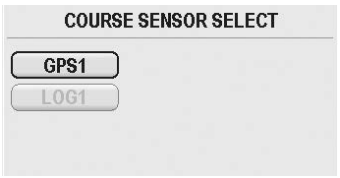
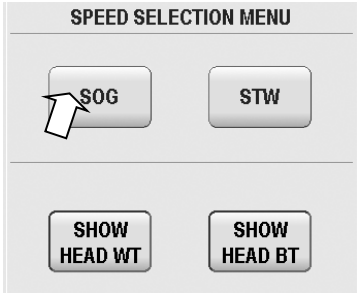
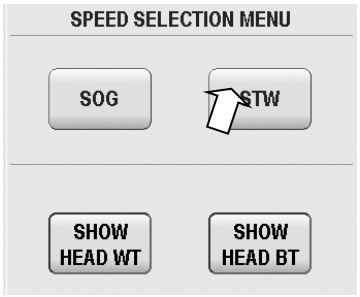
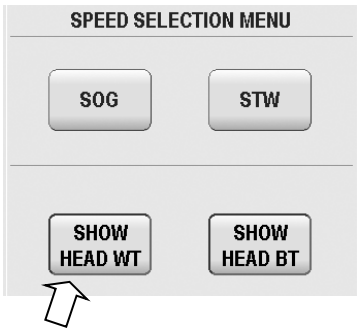
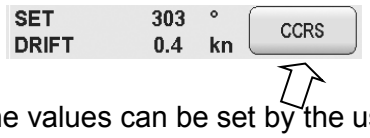
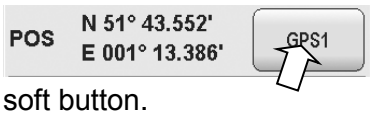
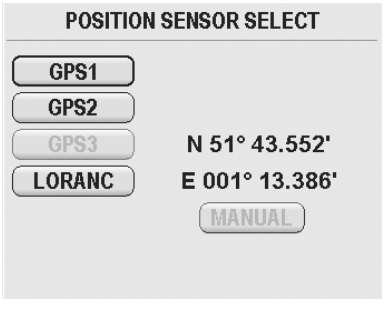


Figure 2-7 Radar Device Selection

Pos.	Information
1	Within this selection possibility, the type of sensor selection is selected.  AUTO MODE In AUTO MODE the OWN ship's data will be monitored by the Consistent Common Reference System (CCRS). The CCRS is a software established for SYNAPSIS INS. The CCRS determines sensor quality and accuracy. The soft key color (GYRO, GPS, LOG and CCRS) is a measure for sensor performance. MANUAL MODE In the MANUAL MODE the OWN ship's data will be selected by the user.

Pos.	Information
2	Within this selection possibility, the type of Heading sensors can be selected in MAN MODE only.  The type of sensor being used is indicated on the selection button (e.g. GYRO1 (T)). Press the GYRO1 soft button.  The Heading Sensor Select window appears in the function display, showing the available heading sensors in this system. If no sensor is available a manual heading value can be used. To set MANUAL input, use the slider function of the manual heading field and confirm selection with the SET button.
3	Within this selection possibility, the type of Course sensor can be selected in MAN MODE only.  Press the GPS1 soft button.  The Course Sensor Select window appears in the function display, showing the available course sensors in this system.
4	Within this selection possibility, the type of Speed sensor (sea or ground stabilized) can be selected in AUTO MODE and MAN MODE. In AUTO MODE a sensor selection is not possible.  Press the GPS1 (BT) soft button. The Speed Selection Menu window appears in the function display.

Pos.	Information
	(WT for Water Track, BT for Bottom Track).  The Speed Selection Menu window appears in the function display. The SOG Sensor Select window appears in the function display, showing the available speed sensors in this system. If no sensor is available a manual SOG value can be entered. To set MANUAL input, use the slider function inside the numerical field.  The STW Sensor Select window appears in the function display, showing the available speed sensors in this system. If no sensor is available a manual STW value can be used. To set MANUAL input, use the slider function from the numeric indicator.  Press the SHOW HEAD WT or SHOW HEAD BT. The VELOCITY VECTOR and stabilization indicator can be used. To SHOW or HIDE the own stabilization indicator select a soft button.

Pos.	Information
	The Water Track (WT) indicator is presented as a single arrowhead. The Bottom Track (BT) indicator is presented as a double arrowhead.
5	CCRS (SET and DRIFT). These values are calculated from CCRS.  In MAN MODE the values can be set by the user. Press the CCRS soft button.  The Set/Drift Sensor Select window appears in the function display. To set MANUAL input, use the slider function inside the numerical field. SET indicates the drift angle in. DRIFT indicates the drift speed in kn.
6	Within this selection possibility, the type of Position sensor can be selected in MAN MODE only.  Press the GPS1 soft button.  The Position Sensor Select window appears in the function display, showing the available position sensors in this system. If no sensor is available a manual position value can be entered. To set MANUAL input, use the slider function inside the field for numerical values and confirm with the SET button.

2.7 SYSTEM STATUS *(INS specific)*

Within the System Status page, the SYNAPSIS INS out hand is displayed in the form of a system block circuit diagram. Within this block circuit diagram, the current status of all applications, devices and interfaces are displayed in color and by means of line patterns.

2.7.1 SYSTEM STATUS Information Page

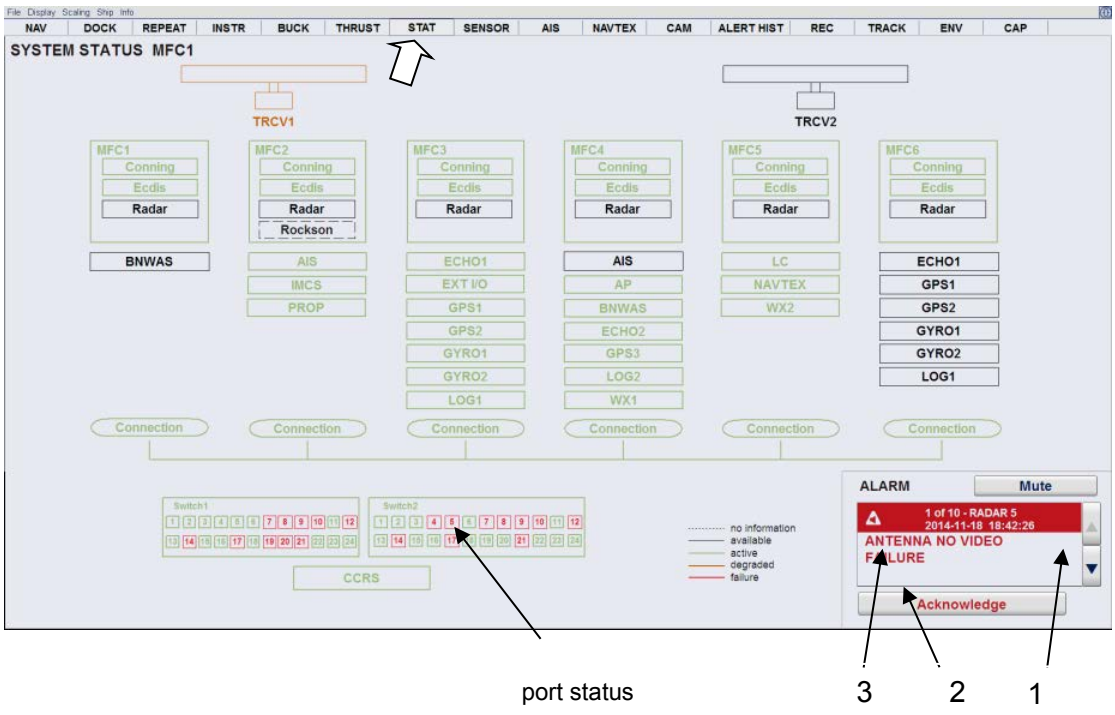


Figure 2-8 SYSTEM STATUS Information Page

Status Indicator	Description
– – – – –	no information
———	available
———	active (GREEN)
———	degraded (ORANGE)
———	failure (RED)

Pos.	Information
1	Soft button (up/down): Selection of an item from the display.
2	Soft button: Acknowledge and MUTE. When the button is pressed, all alarms and warnings are muted for 30 seconds.
3	Text message

3 CCRS Data Processing

3.1 CCRS Principle

The SYNAPSIS INS contains a Consistent Common Reference System (CCRS) which ensures that all parts of the system work with the same navigational data.
The CCRS

- collects all available sensor data,
- checks sensor data for validity, plausibility, and integrity,
- corrects sensor data according to the CCRP of the vessel,
- publishes a consistent set of navigational data to the rest of the system,
- monitors and rates quality of sensor data,
- selects the most suitable sensors in automatic sensor selection mode,
- calculates derived related, connected data,
- synchronizes the time within the system

Figure 3-1 depicts the flow of sensor data through the CCRS. The following sections describe the steps of data processing in detail.

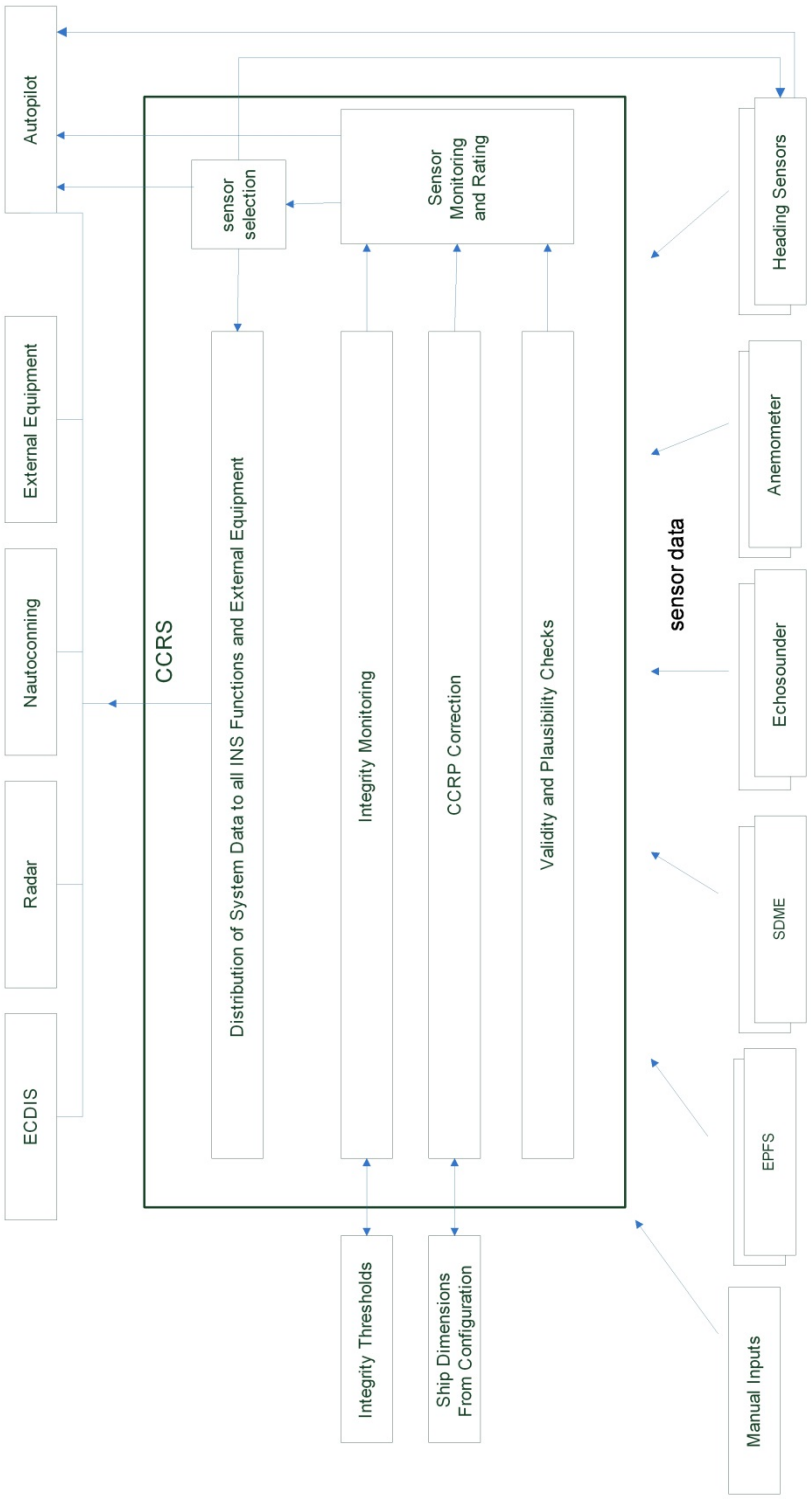


Figure 3-1 CCRS Data Flow

3.2 Valid Input Data

Sensors which shall be used as sources for data are configured by the SYNAPSIS service tool. For each type of data, a so-called degradation path is defined. A degradation path contains all sensors used as sources for this type of data ordered by priority. The first sensor in the list is assigned the highest priority.

The CCRS processes the following NMEA sentences from the source sensors. Field names correspond to the sentence definition in IEC 61162-1 or NMEA 0183.

Table 3-1 Sentence Specific Criteria for Valid Data

Type of Data	NMEA	Sentence Specific Criteria for Valid Data
position	GGA	UTC of position, latitude, longitude, and quality indicator shall be correctly formatted. The UTC of position shall not differ more than 1 minute from the current UTC system time. The GPS quality indicator shall be 1, 2, 3, 4, 5.
	GLL	UTC of position, latitude, longitude, and mode indicator shall be correctly formatted. The UTC of position shall not differ more than 1 minute from the current UTC system time. Status shall be A (=data valid). Mode indicator shall be A, D, P, F, R.
	GNS	UTC of position, latitude, longitude, and mode indicators shall be correctly formatted. The UTC of position shall not differ more than 1 minute from the current UTC system time. Mode indicator shall be A, D, P, F; R.
	RMA	Latitude, longitude, and status shall be correctly formatted. Status shall be A (=data valid).
	RMC	UTC of position, latitude, longitude, and status shall be correctly formatted. The UTC of position shall not differ more than 1 minute from the current UTC system time. Status shall be A (=data valid).
course	VTG	All values shall be correctly formatted.

Type of Data	NMEA	Sentence Specific Criteria for Valid Data
		Mode indicator shall be A, D, P, F, R. Mode indicator shall be identical to the mode indicator of the corresponding position sentence.
	RMA	Course over ground and status shall be correctly formatted. Status shall be A (=data valid).
	RMC	Course over ground and status shall be correctly formatted. Status shall be A (=data valid).
heading	HDT	The heading value shall be correctly formatted.
	HDG	Values shall be correctly formatted.
	THS	Heading value shall be correctly formatted. Mode indicator shall be A.
rate of turn	ROT	Rate of turn value shall be correctly formatted. Status shall be A (=data valid).
speed over ground	VBW	Values shall be correctly formatted. Status ground speed shall be A (=data valid.)For stern transverse ground speed, status stern ground speed shall be A (=data valid).
	VTG	All values shall be correctly formatted. Longitudinal and transversal components have to be provided. Mode indicator shall be A, D, P, F, R.
	RMA	Speed over ground and status shall be correctly formatted. Status shall be A (=data valid).
	RMC	Speed over ground and status shall be correctly formatted. Status shall be A (=data valid).
speed through water	VHW	Speed values shall be correctly formatted or one of the values may be empty. Speed in knots is preferred to speed in km/h.
	VBW	Values shall be correctly formatted. Status water speed shall be A (=data valid.)For stern transverse

Type of Data	NMEA	Sentence Specific Criteria for Valid Data
		water speed, status stern water speed shall be A (=data valid).
roll / pitch	PANZHRP	Values shall be correctly formatted. . Longitudinal and transversal components have to be provided. Status shall be A (=data valid).
depth	DBK	Depth values shall be correctly formatted. At least one value shall be not empty. Priority of values: depth in meters, depth in feet, depth in fathoms.
	DBS	
	DBT	
	DPT	Water depth and offset shall be correctly formatted.
set and drift	VDR	Values shall be correctly formatted.
wind	MWD	Values shall be correctly formatted; one field for direction and speed may be empty. Wind direction true is preferred to wind direction magnetic. Wind speed in knots is preferred to wind speed in m/s.
	MWV	Values shall be correctly formatted. Status shall be A (=data valid).
humidity	MHU	Values shall be correctly formatted.
air pressure	MMB	Values shall be correctly formatted. Pressure in bar is preferred to pressure in inches of mercury.
air temperature	MTA	The value shall be correctly formatted.
water temperature	MTW	The value shall be correctly formatted.
time	ZDA	The values shall be correctly formatted.

All sentences are checked for a valid checksum.
It is possible to suppress checksum validation for NMEA sentences from dedicated sensors. Suppression of checksum validation is not recommended and only used at own risk.
Sensor data is only used if it passes the validity criteria.

3.3 Criteria Plausibility Checks

The CCRS performs a range check and partially a jump detection on incoming sensor data. Sensor data is only used if the values are in range and no jumps have been detected.

Table 3-2 Criteria for Plausibility Checks

Type of Data	Jump Detection	Minimum Value	Maximum Value
position	yes	Latitude 0° Longitude 0°	Latitude 90° N/S Longitude 180°E/W
course	no	0°	359.9°
heading	yes	0°	359.9°
rate of turn	yes	maximum rate of turn as configured by the SYNAPSIS service tool	
speed over ground	no	maximum speed of the vessel as configured by the SYNAPSIS service tool + 20% for speed caused by drift effects.	
speed through water	no		
roll/pitch	no	-90° Rates: -90°/s	90° Rates: -90°/s
depth	no	0m	no limit (theoretical value: 15000m)
set and drift	no	set: 0°	set: 359.9°
wind	no	0kn	250kn
humidity	no	dew point: -30°C humidity: 0%	dew point: 70°C humidity: 100%
air pressure	no	850hPa	1100hPa
air temperature	no	-80°C	80°C
water temperature	no	-10°C	40°C
time	no	valid date and time	valid date and time

Position and SOG/COG from one sensor must share a common mode indicator. It is not allowed to use a position derived in autonomous mode while SOG/COG was calculated in differential mode.

3.4 Sensor Timeouts

The CCRS monitors the sensors for valid and plausible data. If the Sensor does not deliver valid and plausible data for the specified timeout period, an alert is generated.

Timeouts can be configured by the SYNAPSIS Service Tool. By default, a timeout of 5s is used.

3.5 CCRP Correction

The CCRS performs a CCRP correction on position, course, speed, and depth values. The mounting points of the sensors have to be configured in the SYNAPSIS service tool. The Consistent Common Reference Point (CCRP) has to be configured in the SYNAPSIS service tool, as well. It is recommended to set the CCRP to the conning position of the vessel.

For CCRP correction, the sensor position, course, and speed are transformed to reflect the position, course, and speed as if the sensor had been mounted at the CCRP. The depth value is transformed to reflect the depth below keel instead the depth below the transducer.

The heading of the vessel is needed to transform sensor data. If no heading is available, CCRP correction fails. This will influence the integrity monitoring process, the sensor quality rating, the automatic sensor selection, and the distributed system-level data.

3.6 Methods of Integrity Verification

The CCRS performs the following methods of monitoring the integrity of data:

Table 3-3 Methods of Integrity Monitoring

Type of Data	Methods of Integrity Monitoring
position	The positions of all position sensors are checked for consistency. Additionally, the position is checked against a dead reckoning position.
course	The course values of all course sensors are checked for consistency.
heading	The heading values of all heading sensors are checked for concordance. Additionally, a model based test based on actual position, heading, rate of turn, and speed is performed and checked for consistency values.
rate of turn	The rate of turn values of all rate of turn sensors are checked for concordance. Additionally, a model based test based on actual position, heading, rate of turn, and speed is performed and checked for consistency values.
speed over ground	The speed over ground values of all speed over ground sensors are checked for consistency.
speed through water	The speed through water values of all speed through water sensors are checked for consistency. If there is only one speed through water sensor, a model based test based on position, heading, rate of turn, speed over ground, speed through water, and drift is performed.
roll/pitch	The roll/pitch values of all roll/pitch sensors are checked for consistency.
depth	The depth values of all depth sensors are checked for consistency. If there is only one echosounder available, the integrity is set to good (GREEN). It is the responsibility of the mariner to check the depth of water against the depth values available from the ENC or paper chart.
set and drift	The Set and Drift values of all Set and Drift sensors are checked for consistency.

Type of Data	Methods of Integrity Monitoring
wind	The wind values of all wind sensors are checked for consistency.
humidity	The humidity values of all humidity sensors are checked for consistency.
air pressure	The air pressure values of all air pressure sensors are checked for consistency.
air temperature	The air temperature values of all air temperature sensors are checked for consistency.
water temperature	The air temperature values of all air temperature sensors are checked for consistency.
time	The time values of all time sensors are checked for consistency. Additionally, the time is checked against the system clock.

3.6.1 Consistency Check

Consistency checks for integrity monitoring are performed in the following way: The values of two sensors are compared. For each sensor, a deviance value is defined setting up an interval around the sensor value. The values are considered to be consistent, if the intervals of both values intersect.

Example 1:
Sensor LOG1 delivers a SOG of 10kn, the sensor LOG2 delivers a SOG of 10.1kn. The configured deviance is 0.5kn. The value 10.1kn - 0.5kn is less than 10kn + 0.5kn (and 10kn +0.5kn are greater than 10.1kn – 0.5kn), therefore, LOG1 and LOG2 are consistent. If LOG2 delivers 12kn, the sensors are not consistent, because 12kn – 0.5kn is greater than 10kn + 0.5kn.

	If the difference between the sensor values is close to the sum of the deviance values of the sensors, even small changes of the sensor values may cause the result of the integrity check to switch between “passed”, “doubtful”, and “failed”.

Example 2:
Sensor LOG1 delivers a SOG of 10kn, LOG2 delivers a SOG of 14kn. The configured deviance is 2kn. Because 10kn+2kn = 14kn-2kn, the integrity test is passed. If the SOG value from LOG2 is increased to a value slightly greater than 14kn (e.g., due to drift or latency effects), the test fails. If the value falls back to 14kn, the test is passed again.

If this is the case, check if the configured deviances are too small. If deviances are not too small, check the sensor values, exclude inappropriate sensors from automatic sensor selection or select sensors manually.

The numbers of passed and failed consistency checks are counted. If there are more passed concordance tests than failed ones, the sensor is considered to be intact. If there are more failed tests than passed ones, the sensor is considered to be not intact. If no test could be performed or the number of passed tests is equal to the number of failed tests, the sensor is considered to have doubtful integrity.

The deviance thresholds for integrity monitoring can be configured in the SYNAPSIS service tool.
By default, the following values are used:

Table 3-4 Deviance Threshold

Type of Data	Deviance Threshold
position	GPS: 50m, DGPS: 25m, Loran-C: 2500m
course	6°
heading	5°
rate of turn	5°/min
speed over ground	2,5kn
speed through water	2,5kn
roll/pitch	10°
depth	50m
wind	10kn
humidity	5%
air pressure	200Pa
air temperature	2°C

Type of Data	Deviance Threshold
water temperature	2°C
time	3s

To reduce influence of data latency, the thresholds are dynamically adapted in the following way:

- The deviance for heading values is increased at high rates of turn.
- The deviance for positions is increased at high speeds.
- The deviance for COG is increased at small SOG values.

3.7 Sensor Monitoring and Rating (IEC 62288 edition 1 and 2)

Based on the result of the integrity check, a quality indicator is assigned to each sensor. Quality indicators are grouped into three categories, marked by colors green, orange, and red. The color design is corresponding to the Presentation Standard IEC 62288 edition 1 and 2. The IEC edition 2 will be used in the future. In this case the color design changed.

Table 3-5 Sensor Monitoring and Rating

<table>
<tr><th>Quality Indicator (IEC 62288 edition 1)</th><th>Quality Indicator (IEC 62288 edition 2)</th><th>Description</th></tr>
<tr><td>(green)</td><td>(green)</td><td>The sensor has good integrity (edition 1 conditions GREEN).
The sensor has good integrity (edition 2 conditions GREEN).</td></tr>
<tr><td>(orange)</td><td>(yellow)</td><td>The sensor has doubtful integrity. Data from this sensor can be used carefully, but not for automatic control functions (edition 1 conditions ORANGE).
The sensor has doubtful integrity. Data from this sensor can be used carefully, but not for automatic control functions (edition 2 conditions YELLOW).
<table><tr><td>  </td><td>If there is only one source for a certain type of data, this source has doubtful integrity. In this case, doubtful integrity is not a marker for an error</td></tr></table></td></tr>
<tr><td>(red)</td><td>(yellow)</td><td>The sensor failed the integrity test (edition 1 conditions RED).
The sensor failed the integrity test (edition 2 conditions YELLOW).</td></tr>
<tr><td>(red)</td><td>(orange)</td><td>No valid and plausible data available from the sensor (edition 1 conditions RED and for edition 2 conditions orange).</td></tr>
</table>

The CCRS creates alerts for missing sensors and failed tests, see the CCRS alert list for details (see section 7).

3.8 Automatic and Manual Sensor Selection

The CCRS supports two modes of sensor selection: automatic sensor selection and manual sensor selection. In automatic sensor selection the CCRS uses the sensor with the best result of the integrity check as a source for the system level data. If there are multiple “best” sensors the sensor with the higher priority (according to the configured degradation path) is used.

The user can exclude sensors from automatic sensor selection with the ENABLE check box. If a sensor is excluded, the sensor cannot be selected even if this sensor has the best quality rating.

In manual sensor selection mode, the user selects the source sensor for the system level data. As long as the sensor delivers data, this data is used. If the sensor does not deliver data, the CCRS switches to the next sensor in the configured degradation path. If the best sensor recovers, the CCRS switches back to the selected sensor. If the user did not choose the best sensor according to the sensor rating of the CCRS, a “BETTER SENSOR AVAILABLE” caution is generated.

3.9 Data Calculation

The CCRS calculates related (connected) data if no direct sensor data is available:

- true wind from relative wind and vice versa
- relative set and drift
- speed at bow and stern
- dead reckoning position

3.10 Time Synchronization

The CCRS synchronizes the time of all MFCs in the system.

If a time sensor (e.g., an EPFS or a radio clock) is available, the CCRS synchronizes the system clock to the time reported by the sensor. Otherwise, a manual time adjustment has to be applied.

4 Integrated Target Management

4.1 Target Association

The integrated target management performs a target association by comparing the position, the speed, and the course of the targets.

Positions given in range/bearing or latitude/longitude coordinates are automatically converted if the own ship position and heading are available.

SOG/COG and STW/CTW are automatically converted if drift is known. As a simplification, it is assumed that the same drift applies to the own ship as well as the target. In the case of relevant drift differences, target association between ARPA and AIS targets may be degraded if the ARPA tracker is operated in water stabilized mode. The course of the target is ignored at low target speeds.

Association and de-association are subject to a hysteresis: position, speed, and course of the targets have to be close enough for a period of time before the target is associated. The association is canceled if position, speed, or course diverges for a period of time.

The system provides a set of predefined, user-selectable association profiles to adapt the sensitivity of the association process:

default – The default profile offers a trade-off between elimination of duplicate targets and unwanted association between targets which are close together.

open sea – The open sea profile favors association by an increased threshold for position differences, a reduced association time and an increased de-association time

coastal waters – The coastal waters profile favors association by a reduced association time and an increased de-association time.

pilotage – The pilotage profile restricts association by smaller allowed differences in position, speed, and course for use in areas with high traffic.

habour berthing – The habour berthing profile favors de-association by smaller allowed differences in position, speed, and course, a high association time and a reduced de-association time for use in areas with high traffic.

anchorage – the anchorage profile may be used in areas with many slow moving targets, because small allowed differences in position, speed, and course, a high association time and a reduced de-association time are used.

The association profile is user-selectable on Collision Avoidance (Radar) and Route Monitoring (ECDIS) displays and affects the whole system. For each profile, the user can adapt the priority of the target sources (e.g., AIS, X-band Radar, S-Band Radar.) Target association can be disabled.

4.2 Target Labels

The integrated target management assigns a unique target id to each target. Additionally, a label can be assigned to each target. The label can be manually entered or derived from AIS static data (MMSI, ship name, call sign), if available. Targets may be displayed on Collision Avoidance (Radar) or Route Monitoring (ECDIS) displays either with the unique target id, the target label, or no label.

4.3 AIS capacity and Limitations for Target Processing and Display

The target management is able to process up to 7000 targets. Processing includes the calculation of collision-relevant data such as CPA/TCPA. If the limit of 7000 targets is reached, a “MAX 7000 TARGETS” warning is raised and additional targets are dropped without processing (corresponding to category of ship/craft 1 from SOLAS V “All ships/craft > 10 000 gross tonnages”).

If the number of processed targets is greater than 1000 targets, a “MAX 1000 DISPLAYED TARGETS” warning is raised. Target management starts to filter out processed targets to avoid to obscure Radar and ECDIS display. Filtering is applied in the following order:

1. sleeping non-dangerous AIS targets
2. active non-dangerous AIS targets with speed < 3kn
3. active non-dangerous AIS targets with speed > 3kn
4. non-dangerous ARPA targets

5 User Settings and Default Displays

The system provides pre-defined default display settings and operational modes for navigation in open sea, coastal waters, pilotage, harbor berthing, and anchorage. Display settings apply to Radar, ECDIS, and Conning displays, each application has specific settings. Only settings of the local display can be applied.

Pre-defined display settings are read-only, but user-defined display settings can be saved based on pre-defined settings or the current settings of an application. User-defined settings can be re-loaded on any MFC of the system. Additionally, the user can transfer the settings from a selected MFC and apply these settings to the local MFC.

When a pre-defined operational mode for Route Monitoring and Route Planning Displays (ECDIS) is selected, the following settings are applied:

Table 5-1 Settings for Route Monitoring and Route Planning Display (ECDIS)

parameter	defaults route monitoring	defaults route planning	open sea	coastal waters	pilotage	harbor berthing	anchorage
display category	standard display	as is	standard display	standard display	standard display	standard display	standard display
selected area	own ship	as is	own ship	own ship	own ship	own ship	own ship
range	3 NM	6 NM	12 NM	6 NM	3 NM	1.5 NM	1.5 NM
past track	on	off	off	off	off	off	off
look-ahead time	6 min	6 min	6 min	6 min	6 min	6 min	6 min
info panel	Track / Navigation	off	Navigation	Navigation	Navigation	Docking	Docking
target overlay	on	off	on	on	on	on	on
search light	on	off	on	on	on	on	on
heading line / course vector	on	off	on	on	on	on	on

Display settings do not affect the primary or secondary route.

When a pre-defined operational mode for Collision Avoidance (Radar) is selected, the following settings are applied:

Table 5-2 Settings for Collision Avoidance (Radar)

parameter	defaults collision avoidance	open sea	coastal waters	pilotage	harbor berthing	anchorage
gain	as is	as is	as is	as is	as is	as is
tuning	as is	as is	as is	as is	as is	as is
range	6 NM	12 NM	6 NM	3 NM	1.5 NM	1.5 NM
range rings	off	off	off	off	off	off
VRM	one VRM on, 0.25NM	off	off	off	off	off
EBL	One EBL on	off	off	off	off	off
parallel index lines	as is	as is	as is	as is	as is	as is
display mode	true motion, north-up	true motion, north-up	true motion, north-up	true motion, north-up	true motion, north-up	true motion, north-up
off-centering	on	on	on	on	on	off
stabilization	ground stab	ground stab	ground stab	ground stab	ground stab	ground stab
trails	on (6min)	on (6min)	on (6min)	on (6min)	on (6min)	on (6min)
past positions	off	off	off	off	off	off
vectors	relative (6min)	relative (6min)	relative (6min)	relative (6min)	relative (6min)	relative (6min)
AIS display	on	on	on	on	on	on
AIS new/lost target alerts	off	off	off	off	off	off
AIS activation on CPA/TCPA	on	on	on	on	on	off
chart	off	off	off	off	off	off
AIS AtoNs,	off	off	off	off	off	off

parameter	defaults collision avoidance	open sea	coastal waters	pilotage	harbor berthing	anchorage
base stations						
AIS outline	on	on	on	on	on	on
AIS filter range	12 NM	24 NM	12 NM	6 NM	3 NM	3 NM
PCP / CPA symbols	off	off	off	off	off	off
CPA warning circle	off	off	off	off	off	off
target label	on	on	on	on	on	on

	Please note, that display settings do not affect the selection of the transceiver or global parameters of integrated target management. Selection of settings is only possible in stand-by mode.

Additional to the settings of a single display, all displays can be changed synchronously by applying a “bridge profile”. In a bridge profile, each display is assigned to a pre-defined or user-defined operational mode. Selecting a bridge profile applies these operational modes to all MFCs included in the bridge profile at once

6 Interfaces and Data Distribution

Figure 6-1 depicts the logic interfaces of the SYNAPSIS INS.

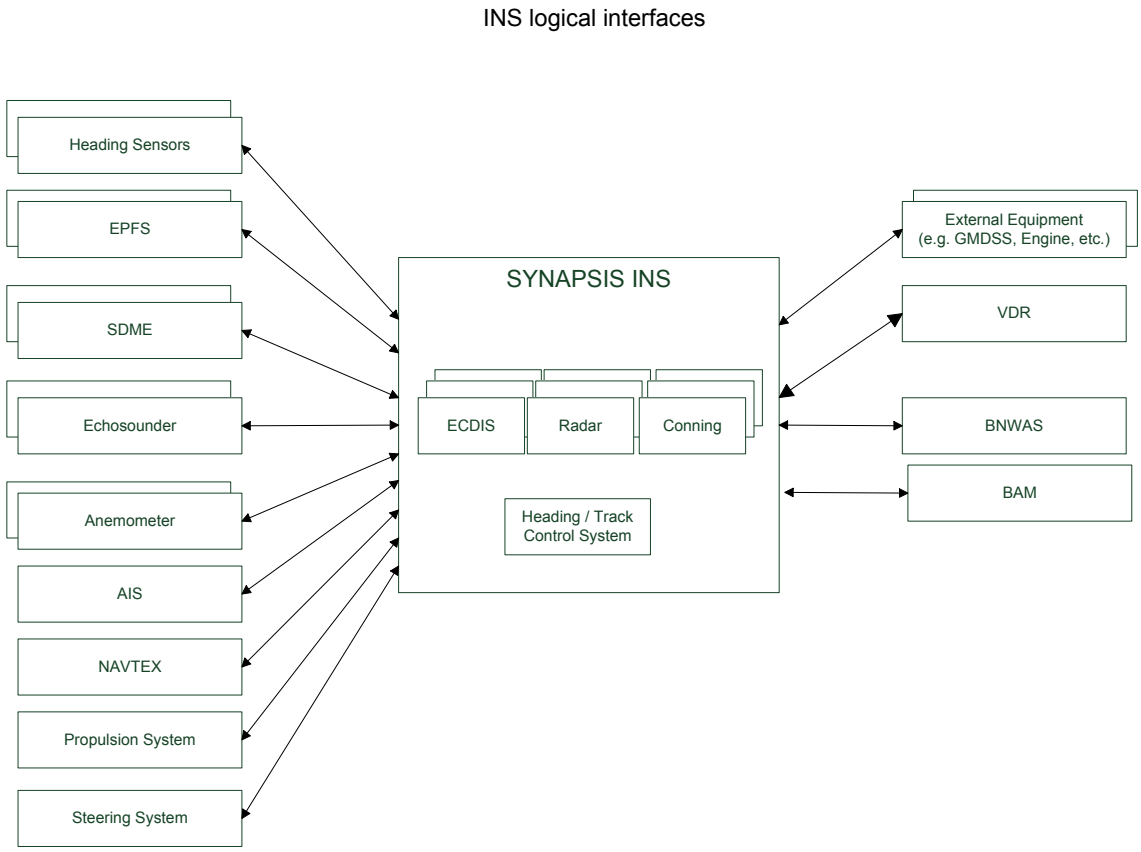


Figure 6-1 Logic Interface of SYNAPSIS INS

6.1 Interface to Standard 22 GYRO Compass System

The SYNAPSIS INS supports a proprietary interface to the Standard 22 Gyro Compass System via a CAN/LAN gateway which allows the INS to receive heading data and compass alerts from the compass system and to select the primary heading sensor within the compass system. If the selected compass is changed at the compass system, the CCRS of the SYNAPSIS INS switches accordingly.

6.2 NMEA Interfaces

The SYNAPSIS INS supports interfaces for the following device types based on NMEA sentences as defined in IEC 61162-1 and proprietary interface specifications.

Table 6-1 NMEA Interfaces

Device Type	NMEA Sentences
Heading Sensors	HDT, HDG, ROT, THS
EPFS	DTM, GLL, GGA, GNS, RMA, RMC, VTG, ZDA
SDME	VBW, VHW, VDR
Echosounders	DBK, DBS, DBT, DPT, VLW
Anemometers	MHU, MMB, MTA, MTW, MWV, MWD
AIS	VDM, VDO, VSD The following types of AIS messages according to ITU-R M.1371 are supported: 1, 2, 4, 3, 5, 6, 8, 9, 12, 14, 18, 19, 21, 24. The system ignores AIS messages which are repeated by AIS base stations to avoid erroneous position reports with high latency.
NAVTEX	NRX
Propulsion System	RPM, PANZRPM
Steering System	ROR, RSA, PANZRSI, ETL, PRC, TRC,TRD

6.3 Interfaces to External Equipment

Additionally to the NMEA sentences listed in section 6.2, the SYNAPSIS INS supports the following NMEA sentences from external equipment:

RTE, WPL, TLB, TTD, TTM, TLL, XTE, ZTG, TRO
PANZCOL, PANZHRP
STRD, STRP

The SYNAPSIS INS is able to deliver the following NMEA sentences as defined in IEC 61162-1 to external equipment:

APB, BWC, BWR, DBK, DBS, DBT, DPT, DTM, GGA, GLL, GNS, HBT, HDG, HDT, HSC, MHU, MMB, MTA, MTW, MWD, MWV, NSR, OSD, POS, RMB, RMC, ROT, RSD, THS, TTD, TLB, TLL, TTM, VBW, VHW, VDR, VTG, XTE, ZDA, ZTG
PANZCOL, PANZETA, PRAYCUR, PRAYMKR

6.4 Output Interface to VDR

The SYNAPSIS INS provides the following NMEA sentences to the voyage data recorder:

ALR, DBK, GGA, HDT, MWV, ROT, RSA, TTM, VBW, VTG, ZDA

6.5 Interfaces to BNWAS

The SYNAPSIS INS provides the following ALR NMEA sentence in case of an emergency call:

$INALR,,260,A,V,Emergency Call*1C<0D><0A>

The sentence is repeated at an interval of 60 seconds as long as there is an escalated alarm. The SYNAPSIS INS accepts an ACK sentence from the BNWAS to acknowledge the emergency call:

$BNACK,260*5D<0D><0A>

After acknowledgement, the SYNAPSIS INS sends the emergency call with the acknowledge flag set to ‘A’:

$INALR,,260,A,A,Emergency Call*0B<0D><0A>

If there is no escalated alarm, the SYNAPSIS INS sends the empty alert list to the BNWAS at an interval of 60 seconds:

$INALR,,,V,V,*74<0D><0A>

Working with the Radar application at a task station which has a proper look out causes the SYNAPSIS INS to send an EVE NMEA sentence to reset the watch alarm:

$--EVE,113011.69,BNWAS,Operator Activity*hh<0D><0A>

The SNAPSIS INS reads the BNWAS status message as defined in IEC 62616-2 for system monitoring purposes (contained status data is an example):

$BNALR,,000,A,V,C1=AUT;C2=03;C3=1*hh<CR><LF>

6.6 Alert Related Communication and System Monitoring

The SYNAPSIS INS supports alert communication with sensors and other external equipment by using ALR and ACK sentences as defined in IEC 61162-1. The SYNAPSIS INS reads ALR sentences and processes these sentences according to IEC 61924-2, Annex L. Alerts are acknowledged by using ACK sentences.

According to IEC 61924-2, all alerts delivered by ALR sentences are mapped to warnings of category B.

The SYNAPSIS INS provides an ALR and ACK based alert interface to the Nautosteer Advanced Steering Control System.

For system monitoring purposes, the SYNAPSIS INS supports HBT and PANZSYS NMEA sentences from external devices. The SYNAPSIS INS is able to deliver the NSR sentence to external equipment e.g. VDR.

The system supports the advanced INS alert communication according to IEC61924-2, based on ALC, ALF, ACN, ARC sentences.

6.7 Required Redundancies

The SYNAPSIS INS shall be connected to backup sensors for

- electronic position fixing
- heading measurement
- speed measurement

6.8 Recommendations for System Design

6.8.1 Redundant AP/GYRO Supply via NautoPlex8plus8

AP and Gyro system receive navigational data (position, time, speed) from the Synapsis system on a serial line. This serial line is connected to the NautoPlex8plus8 interface connection box. The data that shall be sent to AP/GYRO is supplied to the NautoPlex8plus8 by the BIP of the MFCs via the navigational network.

To avoid loss of data in case of failure or shutdown of one MFC (single point of failure) it is recommended to integrate the serial port redundantly on two MFCs. Redundant integration of serial ports is configured via Synapsis Service Tool (see section “Configuration Integrated Devices”).

6.8.2 Redundant AIS Supply

It is recommended to connect AIS on a second workstation or NautoPlex interface at least for Rx (target information from AIS to INS).

7 CCRS and System Monitoring Alert List

7.1 Overview

The following table gives a brief overview of all alerts generated by the CCRS. All alerts in this table are category B which means they can be acknowledged and muted at the Central Alert HMI. Please refer to the listed section of this document for troubleshoot guidance.

Table 7-1 Monitoring Alert List

Short Text	LongText	Priority	Reason	Section
SENSOR TIMEOUT	AIR PRESSURE: NOT AVAILABLE	alarm	The CCRS is not able to provide the mentioned data, e.g., due to sensor failures. INS functions depending on the missing data will not work correctly.	7.2.15
	AIR TEMP: NOT AVAILABLE	alarm		7.2.17
	WATER DEPTH: NOT AVAILABLE	alarm		7.2.11
	HEADING: NOT AVAILABLE	alarm		7.2.8
	HUMIDITY: NOT AVAILABLE	alarm		7.2.16
	ROLL/PITCH: NOT AVAILABLE	alarm		7.2.14
	POSITION: NOT AVAILABLE	alarm		7.2.1
	ROT: NOT AVAILABLE	alarm		7.2.10
	SET AND DRIFT: NOT AVAILABLE	alarm		7.2.7
	COG/SOG: NOT AVAILABLE	alarm		7.2.5
	WATER SPEED: NOT AVAILABLE	alarm		7.2.6
	WATER TEMP: NOT AVAILABLE	alarm		7.2.18
	WIND: NOT	alarm		7.2.13

Short Text	LongText	Priority	Reason	Section
	AVAILABLE			
SENSOR TIMEOUT	>>DATA<<: NOT AVAILABLE FROM >>SENSOR<< (NOT) IN USE	warning caution	The CCRS expects data from a certain sensor (named in the alert text instead of the placeholder >>SENSOR<< but the sensor does not deliver valid and plausible data.	7.2.19
INTEGRITY TEST FAILED	>>DATA<<: POOR INTEGRITY	warning	The integrity check for >>DATA<< was not successful because data from different sensors differ too much.	7.2.20
UTC ERROR	UTC TIME DEVIATION MORE THAN >>DIFFERENCE<<	warning	The INS was not able to synchronize the system time with the selected time sensor because the current system time differs too much from the time reported by the sensor.	7.2.12
DR WARNING	SWITCHING TO DEAD RECKONING	warning	Position sensors do not deliver valid and plausible position data. Therefore, the system uses a position calculated by dead reckoning.	7.2.3
POS TIME MISMATCH	GPS TIME AND SYSTEM TIME DO NOT MATCH	warning	The system time of the INS and the current time of the position sensors do not match. Therefore, position data is rejected.	7.2.2

Short Text	LongText	Priority	Reason	Section
			This warning is an indication for a wrong system time.	
MODE MISMATCH	>>SENSOR<<: MODE INDICATOR INCONSISTENT		The sensor delivers position and SOG data with different mode indicators.	7.2.4
BETTER SENSOR	>>DATA<<: BETTER SENSOR AVAILABLE	caution	There is a better sensor available for >>DATA<< but the system is in manual selection mode. Therefore, the system will not switch to the better sensor automatically.	7.2.21
NO CCRS BACKUP	CCRS BACKUP LOST	warning	There is no redundancy for the CCRS in the system. There is only one available task station which operates normally.	7.2.22
CCRP FAILURE	POSITION AND SPEED ARE NOT REFERENCED TO CCRP	warning	This is a subsequent failure due to loss of heading data.	7.2.9
AIS CCRP MISMATCH	AIS CCRP DIFFERS FROM INS CCRP	caution	The ship dimensions or the CCRP which has been configured at the AIS transponder is different from the CCRP configured at the INS.	7.2.23
GYRO HEATING GYRO SETTLING	>>SENSOR<< IS HEATING – HEADING IS NOT	warning caution	The gyro is currently in heating or settling mode.	7.2.24

Short Text	LongText	Priority	Reason	Section
	USED >>SENSOR<< IS SETTLING – HEADING IS NOT USED		That's why, the heading and rate of turn from this gyro is not used within the INS.	
UNCORRECTED HDG	HEADING FROM >>SENSOR<< IS UNCORRECTED	warning caution	The heading from the given sensor is not corrected due to missing speed or position.	7.2.25
WMM EXPIRED	WMM COEFFICIENT FILE HAS EXPIRED	warning	The world magnetic model used to correct magnetic headings has expired.	7.2.26
WMM WILL EXPIRE	WMM COEFFICIENT FILE WILL EXPIRE WITHIN 30 DAYS	caution	The world magnetic model used to correct magnetic headings will expire within 30 days.	7.2.27
WMM MISSING	WMM COEFFICIENT FILE IS INVALID OR MISSING	warning	The coefficient file for the world magnetic model is missing or corrupt.	7.2.28
DEV TBL MISSING	MAGNETIC DEVIATION TABLE IS NOT INITIALIZED	caution	The magnetic deviation table has not been initialized.	7.2.29
SEL TIMEOUT	COMPASS SYSTEM: UNABLE TO SELECT SENSOR AT CCRS	alarm	sensor selection between INS and compass system could not be synchronized	7.2.30
SEL FAILED	CCRS: UNABLE TO SELECT SENSOR AT COMPASS SYSTEM	alarm	sensor selection between INS and compass system could not be synchronized	7.2.31

7.2 Detailed Description

7.2.1 POSITION DATA AVAILABLE

Priority:	alarm
Category:	B
Short Text:	SENSOR ERROR
Long Text:	POSITION: NOT AVAILABLE
Reason:	The CCRS is not able to provide position data to the tasks of the INS because • there is no sensor available which delivers position • no data is received from the connected position sensors • position data received from the position sensors is not valid or not plausible
Impact:	Subsequent INS functions depending on position data will not work correctly.
Troubleshooting:	1. Identify the position sensors which are expected by the CCRS. The expected position sensors can be seen at the Conning sensor selection display or the CCRS configuration page in the service tool. All your position sensors shall be listed here. Add the position sensors by using the service tool. 2. Look for warnings and cautions for sensor timeout for these sensors, e.g. POSITION: NOT AVAILABLE FROM SENSOR GPS1 IN USE Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.2 GPS TIME AND SYSTEM TIME DO NOT MATCH

Priority:	warning
Category:	B
Short Text:	POS TIME MISMATCH
Long Text:	GPS TIME AND SYSTEM TIME DO NOT MATCH
Reason:	The system time and the time of the position data reported by the position sensors do not match. This may be caused by unsynchronized system clocks of the INS task stations.
Impact:	Position data cannot be used.
Troubleshooting:	1. Check the system time of the INS. The time shall match the current UTC time. If not, synchronize the system time to the current UTC time. 2. Look for alerts caused by broken time sensors (see section 7.2.12 and 7.2.19). If there is such an alert, continue troubleshooting by resolving these alerts. 3. Use the interface viewer of the service tool to monitor ZDA sentences from the sensors. Reported UTC times shall match current UTC time. If not, the sensors deliver wrong time data. 4. If the system time matches UTC time, use the interface view of the service tool to monitor the NMEA data received from the position sensors. The timestamps in the GGA, GLL, GNS, and RMC sentences (if present) shall match the current UTC time, too. If there is a significant time difference between the time of the position sensor and the current UTC time, the position sensor is broken or receives an invalid or spoofed signal.

7.2.3 SWITCHING TO DEAD RECKONING

Priority:	warning
Category:	B
Short Text:	DR POSITION
Long Text:	SWITCHING TO DEAD RECKONING
Reason:	No position data is available from the position sensors. The system uses dead reckoning to estimate the current position of the vessel.
Impact:	The position estimated by dead reckoning is of poor quality and degrades over time.
Troubleshooting:	1. Look for warnings and cautions for sensor timeouts for position sensors, e.g., POSITION: NOT AVAILABLE SENSOR GPS1 IN USE. Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.4 >>SENSOR<<: MODE INDICATIOR INCONSISTENT

Priority:	caution
Category:	B
Short Text:	MODE MISMATCH
Long Text:	>>SENSOR<<: MODE INDICATOR INCONSISTENT
Reason:	The sensor delivers position and SOG data with different mode indicators, e.g., position from differential mode and SOG from autonomous mode. This is forbidden for INS systems.
Impact:	Because SOG is derived from position data, this behavior indicates a sensor error and sensor data is not plausible.
Troubleshooting:	Start troubleshooting the sensor. The sensor has to report the same mode indicators in position data sentences (e.g., GGA, GLL, GNS, RMC) and SOG sentences (VTG). If the system is not an INS, deactivate the check in the SYNAPSIS service tool.

7.2.5 COG/SOG: NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: COG/SOG: NOT AVAILABLE

Reason: The CCRS is not able to provide speed over ground or course over ground data to the tasks of the INS because

- there is no sensor available which delivers speed over ground and course over ground
- no data is received from the connected sensors
- speed over ground or course over ground data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on speed over ground or course over ground data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver speed over ground and course over ground. The expected sensors can be seen at the Conning sensor selection display or the CCRS configuration page in the service tool. All your position sensors and all your logs delivering speed over ground shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   COG/SOG: NOT AVAILABLE FROM SENSOR GPS1 IN USE
   Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.6 WATER SPEED: NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: WATER SPEED: NOT AVAILABLE

Reason: The CCRS is not able to provide speed through water data to the tasks of the INS because

- there is no sensor available which delivers speed through water
- no data is received from the connected sensors
- speed through water data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on speed through water data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver speed through water. The expected sensors can be seen at the Conning sensor selection display or the CCRS configuration page in the service tool. All your logs shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   WATER SPEED: NOT AVAILABLE FROM SENSOR DOLOG IN USE
   Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.7 SET AND DRIFT: NOT AVAILBLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: SET AND DRIFT: NOT AVAILABLE

Reason: The CCRS is not able to provide set and drift data to the tasks of the INS because

- there is no sensor available which delivers set and drift and
- the CCRS is not able to calculate set and drift because some of the following data is missing:
    - speed over ground
    - course over ground
    - speed through water
    - heading
- no data is received from the connected sensors
- set and drift data received from the sensors or calculated by the INS is not valid or not plausible

Impact: Subsequent INS functions depending on set and drift data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver set and drift. The expected sensors can be seen at the CCRS configuration page in the service tool. If there are any sensors which deliver set and drift, add them by using the service tool.
2. Ensure that the following alarms are not present:
    - HEADING: NOT AVAILABLE
    - WATER SPEED: NOT AVAILABLE
    - COG/SOG: NOT AVAILABLE
3. If any of the listed alarms is present, continue troubleshooting by resolving these alarms see sections 7.2.5, 7.2.9, 7.2.8 and 7.2.6.
4. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   SET/DRIFT: NOT AVAILABLE FROM SENSOR DOLOG IN USE Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.8 HEADING: NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: HEADING: NOT AVAILABLE

Reason: The CCRS is not able to provide heading data to the tasks of the INS because

- there is no gyro or magnetic compass available
- no data is received from the connected sensors
- heading data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on heading data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver heading. The expected sensors can be seen at the Conning sensor selection display or the CCRS configuration page in the service tool. All your gyros shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   HEADING: NOT AVAILABLE FROM SENSOR GYRO1 IN USE
   Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.9 POSITION AND SPEED ARE NOT REFERENCED TO CCRP

Priority: warning

Category: B

Short Text: CCRP FAILURE

Long Text: POSITION AND SPEED ARE NOT REFERENCED TO CCRP

Reason: The CCRS needs the current heading of the vessel to calculate the position of the CCRP as well as the speed of the vessel at the CCRP from the sensor data. If no heading is available, the CCRP correction is not correct.

Impact: The position displayed by the INS is not the position of the CCRP. There may be an error of at most 2 times the distance between the CCRP and the mounting point of the selected position sensor. Correction of speed values is also wrong.

Because the error depends on the mounting point of each sensor, the integrity check for position and speed may fail.

Troubleshooting:

1. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   HEADING: NOT AVAILABLE FROM SENSOR GYRO1 IN USE
   Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.10 Rot. NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: RATE OF TURN: NOT AVAILABLE

Reason: The CCRS is not able to provide rate of turn data to the tasks of the INS because

- there is no sensor for rate of turn available
- no data is received from the connected sensors
- rate of turn data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on rate of turn data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver rate of turn. The expected sensors can be seen at the Conning sensor selection display or the CCRS configuration page in the service tool. All your sensors which deliver rate of turn shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   ROT: NOT AVAILABLE FROM SENSOR GYRO1 IN USE
   Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.11 WATER DEPTH: NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: WATER DEPTH: NOT AVAILABLE

Reason: The CCRS is not able to provide depth below keel and depth of water data to the tasks of the INS because

- there is no sensor for water depth
- no data is received from the connected sensors
- water depth data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on water depth data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver water depth. The expected sensors can be seen at the Conning sensor selection display or the CCRS configuration page in the service tool. All your echo sounders shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   WATER DEPTH: NOT AVAILABLE FROM SENSOR SND1 IN USE Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.12 UTC TIME DEVIATION MORE THAN >>DIIFERENCE<<

Priority:	warning
Category:	B
Short Text:	UTC ERROR
Long Text:	UTC TIME DEVIATION MORE THAN >>DIFFERENCE<<
Reason:	The CCRS will only synchronize the system time with an external clock if the difference between the current system time and the time reported by the external clock is less than preconfigured difference (e.g., 4 days.)
Impact:	System time is not synchronized with the external clock. This will generate subsequent alerts such as 7.2.2 and effects all time based monitoring functions of the INS.
Troubleshooting:	Use the SYNAPSIS service tool to set the system time of all task stations to the current UTC time. If the warning does not disappear, use the interface view of the service tool to monitor the NMEA sentences (ZDA) from the external clock. The UTC time reported by the external clock shall match the current UTC time. If there is a significant deviation, the external clock is broken or receives an invalid or spoofed time signal.

7.2.13 WIND: NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: WIND: NOT AVAILABLE

Reason: The CCRS is not able to provide wind data to the tasks of the INS because

- there is no wind sensor available
- no data is received from the connected sensors
- wind data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on wind data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver wind data. The expected sensors can be seen at the CCRS configuration page in the service tool. All your anemometers shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   WIND: NOT AVAILABLE FROM SENSOR WX1 IN USE
   Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.14 ROLL/PITCH: NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: ROLL/PITCH: NOT AVAILABLE

Reason: The CCRS is not able to provide roll or pitch data to the tasks of the INS because

- there is no MINS available, but the CCRS shall process roll and pitch
- no data is received from the connected MINS or roll/pitch sensors
- roll and pitch data received from the MINS or roll/pitch is not valid or not plausible

Impact: Subsequent INS functions depending on roll and pitch data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver roll and pitch data. The expected sensors can be seen at the CCRS configuration page in the service tool. All your roll/pitch sensors shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   ROLL/PITCH: NOT AVAILABLE FROM SENSOR MINS1 IN USE
   Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.15 AIR PRESSURE DATA NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: AIR PRESSURE: NOT AVAILABLE

Reason: The CCRS is not able to provide air pressure data to the tasks of the INS because

- there is no sensor available, but the CCRS shall process air pressure
- no data is received from the connected sensors
- air pressure data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on air pressure data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver air pressure data. The expected sensors can be seen at the CCRS configuration page in the service tool. All your sensors delivering air pressure data shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   AIR PRESSURE: NOT AVAILABLE FROM SENSOR WX1 IN USE Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.16 HUMMIDITY: NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: HUMIDITY: NOT AVAILABLE

Reason: The CCRS is not able to provide humidity data to the tasks of the INS because

- there is no sensor available, but the CCRS shall process humidity
- no data is received from the connected sensors
- humidity data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on humidity data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver humidity data. The expected sensors can be seen at the CCRS configuration page in the service tool. All your sensors delivering humidity data shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   HUMIDITY: NOT AVAILABLE FROM SENSOR WX1 IN USE
   Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.17 AIR TEMP: NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: AIR TEMP: NOT AVAILABLE

Reason: The CCRS is not able to provide air temperature data to the tasks of the INS because

- there is no sensor available, but the CCRS shall process air temperature
- no data is received from the connected sensors
- humidity data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on air temperature data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver air temperature data. The expected sensors can be seen at the CCRS configuration page in the service tool. All your sensors delivering air temperature data shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   AIR TEMP: NOT AVAILABLE FROM SENSOR WX1 IN USE
   Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.18 WATER TEMP: NOT AVAILABLE

Priority: alarm

Category: B

Short Text: SENSOR TIMEOUT

Long Text: WATER TEMP: NOT AVAILABLE

Reason: The CCRS is not able to provide water temperature data to the tasks of the INS because

- there is no sensor available, but the CCRS shall process water temperature
- no data is received from the connected sensors
- water temperature data received from the sensors is not valid or not plausible

Impact: Subsequent INS functions depending on water temperature data will not work correctly.

Troubleshooting:

1. Identify the sensors which are expected by the CCRS to deliver water temperature data. The expected sensors can be seen at the CCRS configuration page in the service tool. All your sensors delivering water temperature data shall be listed here. If not, add these sensors by using the service tool.
2. Look for warnings and cautions for sensor timeout for these sensors, e.g.
   WATER TEMP: NOT AVAILABLE FROM SENSOR WX1 IN USE Continue troubleshooting by resolving these warnings and cautions see section 7.2.19.

7.2.19 >>DATA<<: NOT AVAILABLE FROM SENSOR >>SENSOR<< (IN USE)

Priority: warning (data is not available from the sensor currently in use)
caution (data is not available from a sensor currently not in use)

Category: B

Short Text: SENSOR TIMEOUT

Long Text: >>DATA<<: NOT AVAILABLE FROM SENSOR >>SENSOR<< IN USE
>>DATA<<: NOT AVAILABLE FROM SENSOR >>SENSOR<<

Reason: The CCRS expects data from a sensor but the sensor does not deliver valid and plausible data.

Impact: The quality indicator of the sensor is lowered and degradation to a redundant sensor takes place. If there is no redundant sensor available, a “not data” alarm is generated (see sections 7.2.1, 7.2.4, 7.2.7, 7.2.8, 7.2.10, 7.2.13, 7.2.14, 7.2.15, 7.2.16, 7.2.17, 7.2.18 .)

Troubleshooting:

1. Open the interface viewer of the service tool. Select the interface(s) where the sensor is connected to. Check the data which is received from the sensor:

   Receives the system any sentences?
   Look for the following NMEA sentences:
   position: GGA, GLL, GNS, RMC
   heading: HDT, HDG, THS
   course: VTG
   time: ZDA
   speed over ground: VTG, VBW
   speed through water: VBW, VHW
   set and drift: VDR
   water depth: DBT, DBK, DBS, DPT
   wind: MWV, MWD
   roll/pitch: PANZHRP, TRO
   air pressure: MMB
   air temperature: MTA
   water temperature: MTW
   humidity: MHU
2. If NMEA data is available, look at the checksum: Is the checksum of the sentences correct?
3. Check validity flags of the NMEA sentences. The CCRS only processes valid data.
4. Check plausibility of data. The CCRS only processes data with plausible magnitudes of values.

5. If data received from the sensor is marked as invalid or not plausible, continue troubleshooting at the sensor which sends invalid data.
6. Otherwise: check data for jumps or high rates of change. CCRS performs a jump detection on position, heading, and rate of turn. Check the maximum speed and maximum rate of turn parameters configured for the vessel for values whether they are too low.
7. If the interface viewer does not show any NMEA sentences from the sensor or the received data is no valid NMEA, check the interface configuration of the sensor (wiring, baud rate of interface, configuration of sensor.)
8. Check that redundant interfaces share a common role arbitration concern.
9. If interface configuration is correct and no data is displayed in the interface viewer, check that the sensor is correctly plugged in and the cable is not damaged.

7.2.20 >>DATA<<: POOR INTEGRITY

Priority:	warning
Category:	B
Short Text:	POOR INTEGRITY
Long Text:	>>DATA<<: POOR INTEGRITY
Reason:	The CCRS compares data from redundant sensors. If the deviance between data from two sensors exceeds the configured threshold, the integrity test fails. Otherwise, the integrity test is passed. The warning is generated when the values of the selected sensor differ from the values of redundant sensors (there are more failed integrity tests for the selected sensor than passed integrity tests or the integrity tests do not have a clear result.) Please note: If there is only one sensor available for a certain data item, the warning is not generated.
Impact:	Data which did not pass the integrity check cannot be used for automatic control functions.
Troubleshooting:	Poor integrity may be the result of a noisy sensor signal. Open the Conning sensor selection page and compare the values. If the difference is acceptable, the deviance thresholds may be configured to a value which is too low. Open the service tool and increase the “absolute deviance” configuration parameters of the sensors. Check that the mounting positions of the sensors are correct. The CCRS performs a CCRP correction on position, speed, course, and depth. Wrong mounting positions cause a wrong CCRP correction which results in a deviance between the values. Check that the heading value used by the system is correct. Heading is an important factor in CCRP correction.

7.2.21 >>DATA<<: BETTER SENSOR AVAILABLE

Priority: caution

Category: B

Short Text: BETTER SENSOR AVAILABLE

Long Text: >>DATA<<: BETTER SENSOR AVAILABLE

Reason: The CCRS works in manual selection mode, a sensor has been manually selected, but there is another sensor which has a better quality.

Impact: This is information for the mariner.

Troubleshooting: The mariner should confirm that the manually selected sensor is the best choice.

7.2.22 CCRS BACKUP LOST

Priority: warning

Category: B

Short Text: NO CCRS BACKUP

Long Text: CCRS BACKUP LOST

Reason: The CCRS runs redundantly on every task station of the INS. This warning occurs when only one CCRS is available in the system.

Impact: This is information for the mariner. If the last CCRS instance fails, the whole INS will miss any sensor data.

Troubleshooting: The warning occurs when either only one task station of the INS works under normal conditions or there is a network error such that communication between the task stations is disturbed. In the first case, restart the other task stations of the INS. In the second case, start troubleshooting of the network components.

7.2.23 AIS CCRP DIFFERS FROM INS CCRP

Priority:	caution
Category:	B
Short Text:	AIS CCRP MISMATCH
Long Text:	AIS CCRP DIFFERS FROM INS CCRP
Reason:	Ship dimensions and CCRP are configured for the INS and the AIS transponder individually. There is a mismatch between both configurations.
Impact:	If the INS configuration of the CCRP or ship dimensions is wrong, the CCRP correction of sensor data will not work correctly. If the AIS configuration is wrong, the AIS target data reported to other vessels is wrong.
Troubleshooting:	Configure the correct ship dimensions and CCRP location (typically the Conning position) both at the INS (by using the service tool) and the AIS transponder.

7.2.24 >>SENSOR<< IS HEATING/SETTLING –HEADING IS NOT USED

Priority:	warning (>>SENSOR<< is the selected heading sensor) caution (>>SENSOR<< is not selected)
Category:	B
Short Text:	GYRO HEATING / GYRO SETTLING
Long Text:	>>SENSOR<< IS HEATING – HEADING IS NOT USED >>SENSOR<< IS SETTLING – HEADING IS NOT USED
Reason:	The given gyro is currently in heating or settling mode. The heading and rate of turn from this gyro are too imprecise to be used within the INS.
Impact:	Heading and rate of turn from a gyro in heating or settling mode cannot be used in the INS. If the user selects a gyro in settling mode manually, no heading and rate of turn information will be available in the INS.
Troubleshooting:	Wait until the gyro finished the heating and settling phase. If the selected heading sensor is currently heating or settling, try to select another gyro which is in normal operation mode.

7.2.25 HEADING FROM >>SENSOR<< IS UNCORRECTED

Priority: warning (>>SENSOR<< is the selected heading sensor)
caution (>>SENSOR<< is not selected)

Category: B

Short Text: UNCORRECTED HDG

Long Text: HEADING FROM >>SENSOR<< IS UNCORRECTED

Reason: Due to missing speed or position data, the heading from the given gyro is not corrected and does not reference to true north.

Impact: The heading reported by the given gyro might be imprecise and may deviate from the real heading of the vessel. Display may show a wrong heading. CPA/TCPA values of ARPA and AIS targets may be wrong. Collision warnings may be wrong or missing. Heading control and navigational calculations may not work correctly. Sensor data may not be CCRP corrected.

Troubleshooting: Check that speed and position data is available (look for missing data and alarms.) If data is missing (e.g., at the Conning display), continue troubleshooting by resolving the alarms.
If speed and position data is available, use the interface viewer of the SYNAPSIS service tool to check the interface between the INS and the compass system if speed and position is reported by the INS correctly and the connection works properly.
If possible, try to enter manual speed and position at the compass system.

7.2.26 WMM COEFFICIENT FILE HAS EXPIRED

Priority:	warning
Category:	B
Short Text:	WMM EXPIRED
Long Text:	WMM COEFFICIENT FILE HAS EXPIRED
Reason:	The coefficient file of the World Magnetic Model (WMM) is too old.
Impact:	Heading values from the magnetic compass cannot be correctly referenced to true north because the current magnetic variation of the earth magnetic field is not known. This alert is only applicable to systems where the INS is responsible to correct magnetic headings.
Troubleshooting:	Download the latest version of the World Magnetic Model coefficient file from the National Oceanic and Atmospheric Administration (NOAA) and install the file according to the system installation manual. URL (May 2014): http://www.ngdc.noaa.gov/geomag/WMM/DoDWMM.shtml

7.2.27 WMM COEFFICIENT FILE

Priority:	caution
Category:	B
Short Text:	WMM WILL EXPIRE
Long Text:	WMM COEFFICIENT FILE WILL EXPIRE WITHIN 30 DAYS
Reason:	The coefficient file of the World Magnetic Model (WMM) will expire within the next 30 days.
Impact:	This is a pre-caution. After the coefficient file has expired, heading values from the magnetic compass cannot be correctly referenced to true north because the current magnetic variation of the earth magnetic field is not known. This alert is only applicable to systems where the INS is responsible to correct magnetic headings.
Troubleshooting:	Download the latest version of the World Magnetic Model coefficient file from the National Oceanic and Atmospheric Administration (NOAA) and install the file according to the system installation manual. URL (May 2014): http://www.ngdc.noaa.gov/geomag/WMM/DoDWMM.shtml

7.2.28 WMM COEFFICIENT FILE IS INVALID OR MISSING

Priority:	warning
Category:	B
Short Text:	WMM MISSING
Long Text:	WMM COEFFICIENT FILE IS INVALID OR MISSING
Reason:	The coefficient file of the World Magnetic Model (WMM) was not correctly installed.
Impact:	Without the coefficient file of the World Magnetic Model, heading values from the magnetic compass cannot be correctly referenced to true north because the current magnetic variation of the earth magnetic field is not known. This alert is only applicable to systems where the INS is responsible to correct magnetic headings.
Troubleshooting:	Download the latest version of the World Magnetic Model coefficient file from the National Oceanic and Atmospheric Administration (NOAA) and install the file according to the system installation manual. URL (May 2014): http://www.ngdc.noaa.gov/geomag/WMM/DoDWMM.shtml

7.2.29 MAGNETIC DEVIATION TABLE IS NOT INITIALIZED

Priority: caution

Category: B

Short Text: DEV TABLE MISSING

Long Text: MAGNETIC DEVIATION TABLE IS NOT INITIALIZED

Reason: The magnetic deviation table was not correctly initialized.

Impact: Without the magnetic deviation information, heading values from the magnetic compass cannot be corrected to exclude the influence of the vessel. Heading from the magnetic compass may be wrong or imprecise.

Troubleshooting: The magnetic deviation table has to be initialized during commissioning. Download the latest version of the World Magnetic Model coefficient file from the National Oceanic and Atmospheric Administration (NOAA) and install the file according to the system installation manual.
URL (May 2014):
http://www.ngdc.noaa.gov/geomag/WMM/DoDWMM.shtml

7.2.30 COMPASS SYSTEM: TO SELECT SENSOR AT CCRS

Priority: alarm

Category: B

Short Text: SEL TIMEOUT

Long Text: COMPASS SYSTEM: UNABLE TO SELECT SENSOR AT CCRS

Reason: A sensor was manually selected at the operator unit of the compass system and the compass system was not able to synchronize this selection with the CCRS of the INS.

Impact: CCRS and compass system (including repeaters) use different heading sensors.

Troubleshooting: Synchronize the CCRS selection with the compass system by selecting the heading sensor manually.
If the failure persists, start troubleshooting the communication between INS and compass system (network cables, configuration of the CAN/LAN gateway).

7.2.31 CCRS: UNABLE TO SELECT SENSOR AT COMPASS SYSTEM

Priority:	alarm
Category:	B
Short Text:	SEL FAILED
Long Text:	CCRS: UNABLE TO SELECT SENSOR AT COMPASS SYSTEM
Reason:	A sensor was selected in CCRS (either manually or automatically.) The CCRS was not able to synchronize this selection with the compass system.
Impact:	CCRS and compass system (including repeaters) use different heading sensors.
Troubleshooting:	Synchronize the sensor selection at the compass system with the CCRS selection. If the failure persists, start troubleshooting the communication between INS and compass system (network cables, configuration of the CAN/LAN gateway).

8 System Monitoring Alerts

8.1 Overview

The following table gives a brief overview over all alerts generated by the system monitoring of the INS. All alerts in this table are category B which means they can be acknowledged and muted at the Central Alert HMI. Please refer to the listed section of this document for troubleshoot guidance.

Table 8-1 System Monitoring Alerts

Short Text	LongText	Priority	Reason	Section
FUNCTION LOST	>>DEVICE<<: FUNCTION LOST	alarm	A connected device is not available or accessible.	8.2.3
LOSS OF SYS COMM	>>DEVICE<<: LOSS OF SYSTEM COMMUNICATION	warning	Alert communication from a system component or sensor is disturbed.	8.2.1
HOST LOST	>>MFC<<: HOST LOST	alarm	A MFC of the INS is not accessible.	8.2.2
NEW SAR MESSAGE	NEW >>TYPE<< MESSAGE RECEIVED	warning	A new safety-related message was received by AIS or Navtex.	8.2.4
TEST ALERT ONLY	TEST ALERT ONLY	warning	The user activated the test alert.	8.2.5
BANDWIDTH LIMIT REACHED	>>SWITCH<< BANDWIDTH LIMIT REACHED	warning	The configured bandwidth limit for one port of >>SWITCH<< has been reached.	8.2.6
PORT LINK FAILURE	>>SWITCH<< LINK FAILURE	warning	The loss of the network link was detected for at least one port of >>SWITCH<<.	8.2.7

8.2 Detailed Description

8.2.1 >>DEVICE<<: LOSS OF SYSTEM COMMUNICATION

Priority:	warning
Category:	B
Short Text:	LOSS OF SYS COMM
Long Text:	>>DEVICE<<: LOSS OF SYSTEM COMMUNICATION
Reason:	Some connected device or INS function is not able to send alerts to the INS.
Impact:	No alerts from this device or function are displayed on the Conning alert page.
Troubleshooting:	Confirm that the device is properly running and connected to the INS. Try to restart the device. If an INS function fails to send alerts, try to restart the MFC where the function runs. If an external device fails to send alerts, check data from the device if any successful connection is established. Monitor the interface data to find ALR or ALC sentences sent from the device with an interval not longer than 60 seconds.

8.2.2 >>MFC<<: HOST LOST

Priority:	alarm
Category:	B
Short Text:	HOST LOST
Long Text:	>>MFC<<: HOST LOST
Reason:	The INS software on the mentioned MFC failed to work properly, the MFC is not accessible because of a network error or the PC of the MFC crashed.
Impact:	The functions on this MFC may be degraded or unavailable. Sensor data from sensors connected to this MFC is not available.
Troubleshooting:	Close all applications on the mentioned MFC and select “Restart BIP” from the Eggshell menu. Restart the applications. If the alert remains active, try to reboot the MFC or start troubleshooting the network connections to this MFC. If the MFC is not started when this alarm is displayed, start the MFC.

8.2.3 >>DEVICE<<: FUNCTION LOST

Priority:	alarm
Category:	B
Short Text:	FUNCTION LOST
Long Text:	>>DEVICE<<: FUNCTION LOST
Reason:	A mandatory application of the INS failed to work properly or a mandatory connected device failed to send data.
Impact:	The affected function will not be available,
Troubleshooting:	If an INS function is affected, try to restart this function or try to restart the affected MFC. If a connected device is affected, start troubleshooting the connection to this device. Look at the interface view in the SYNAPSIS service tool to ensure that the device sends valid data.

8.2.4 NEW >>TYPE<< MESSAGE RECEIVED

Priority:	warning
Category:	B
Short Text:	NEW SAR MESSAGE
Long Text:	NEW NAVTEX MESSAGE RECEIVED NEW AIS MESSAGE RECEIVED
Reason:	A new safety-related message has been received via Navtex or AIS.
Impact:	
Troubleshooting:	Read the message in ECDIS or Conning and acknowledge the warning.

8.2.5 TEST ALERT ONLY

Priority:	warning
Category:	B
Short Text:	TEST ALERT ONLY
Long Text:	TEST ALERT ONLY
Reason:	The user activated the test alert in an application
Impact:	The test alert can be used to test alert communication in the system and with external systems. The alert will be rectified after 60 seconds.
Troubleshooting:	Acknowledge the alert and wait until the alert is rectified after 60 seconds.

8.2.6 >>SWITCH<< BANDWIDTH LIMIT REACHED

Priority:	warning
Category:	B
Short Text:	BANDWIDTH LIMIT REACHED
Long Text:	>>SWITCH<< BANDWIDTH LIMIT REACHED
Reason:	The configuration bandwidth limit for one port of >>SWITCH<< has been reached.
Impact:	Reaching the bandwidth limit may result in loss of data messages between consoles and /or connected devices.
Troubleshooting:	Check the INS status page on the Conning (System Status Display) to see which ports bandwidth limit has been reached. Use the system connection diagram to identify the connected console/device. Try to restart the connected console/device. Use the SYNAPSIS Service Tool (Doc. No. 4280) to check the configured bandwidth limit for the affected port.

8.2.7 >>SWITCH<< LINK FAILURE

Priority:	warning
Category:	B
Short Text:	PORT LINK FAILURE
Long Text:	>>SWITCH<< LINK FAILURE
Reason:	The loss of network link was detected for at least one port of >>SWITCH<<.
Impact:	No communication with the console/device connected to this port.
Troubleshooting:	Check the INS status on the Conning (System Status Display) to see for which ports the loss of network link has been detected. Use the system connection diagram to identify the connected console/device. Try to restart the connected console/device. Check the corresponding network cable (wire break).

9 Target Related Alerts

9.1 Overview

Target-related alerts are managed by the integrated target management of SYNAPSIS. Although most target-related alerts are category A, they can be acknowledged at any SYNAPSIS RADAR and ECDIS display because the integrated target management provides all information for a proper assessment of the collision avoidance decision to all displays.
Please ensure to enable the target overlay in ECDIS and to turn on AIS display in RADAR when assessing target-related alerts!

Table 9-1 Target Related Alerts

Short Text	LongText	Priority	Reason	Section
CPA / TCPA	CPA TCPA BY >>COUNT<< TARGET(S)	alarm	One or more targets violate the selected CPA/TCPA thresholds. Danger of collision!	9.2.1
LOST TARGET	LOST >>COUNT<< TARGET(S)	warning	One or more targets are no longer available.	9.2.2
NEW TARGET	>>COUNT<< NEW TARGET(S) FROM >>SOURCE<<	warning	One or more targets were newly acquired or activated.	9.2.3
NEW TARGET	>>COUNT<< NEW TARGET(S)	warning	One or more targets were newly acquired or activated at different sources.	9.2.4
GUARD ZONE INTR	GUARD ZONE INTRUSION BY >>COUNT<< TARGET(S)	alarm	One or more targets entered a defined guard zone.	9.2.5
LOST REF TARGET	LOST REFERENCE TARGET	warning	The selected reference target was lost.	9.2.6
MAX >>COUNT<< TARGETS	MAX >>COUNT<< TARGETS	warning	The integrated target management reached the maximum manageable number of targets.	9.2.7

9.2 Detailed Description

9.2.1 CPA TCPA BY >>COUNT<< TARGET(S)

Priority: alarm

Category: A

Short Text: CPA TCPA

Long Text: CPA TCPA BY >>COUNT<< TARGET(S)

Reason: Some targets violate the current CPA/TCPA thresholds.

Impact: Danger of collision!

Troubleshooting: The dangerous targets are marked as dangerous targets on all RADAR PPIs and ECDIS displays. When assessing the situation at ECDIS, ensure that the target overlay is displayed. Check all dangerous targets for potential collisions and perform all necessary actions according to the rules to avoid these collisions.

9.2.2 LOST >>COUNT<< TARGET(S)

Priority: warning

Category: A

Short Text: LOST TARGET

Long Text: LOST >>COUNT<< TARGET(S)

Reason: Collision avoidance data for some targets is no longer available.

Impact: Collision alerts for these targets are no longer available.

Troubleshooting: Check all lost targets for the reason of losing the target. Target loss is normal when the target leaves the tracking range of the ARPA tracker (24 NM) or the reporting range of AIS. In other cases, check the lost targets for potential danger of collision.

9.2.3 >>COUNT<< NEW TARGET(S) FROM >>SOURCE<<

Priority:	warning
Category:	A
Short Text:	NEW TARGET
Long Text:	>>COUNT<< NEW TARGET(S) FROM >>SOURCE<<
Reason:	A new target was automatically acquired by the specified ARPA tracker or automatically activated by AIS processing.
Impact:	The target will be monitored for a potential danger of collision.
Troubleshooting:	This is a notification of the user. Acknowledge the alert. The alert is automatically replaced by the >>COUNT<< NEW TARGET(S) alerts when multiple sources acquired or activated new targets.

9.2.4 >>COUNT<< NEW TARGET(S)

Priority:	warning
Category:	A
Short Text:	NEW TARGET
Long Text:	>>COUNT<< NEW TARGET(S)
Reason:	A new target was automatically acquired by an ARPA tracker or automatically activated by AIS processing. This alert is an aggregated alert if the target management detects multiple new targets from different sources.
Impact:	The target will be monitored for a potential danger of collision.
Troubleshooting:	This is a notification of the user. Acknowledge the alert.

9.2.5 GUARD ZONE INTRUSION BY >>COUNT<< TARGET(S)

Priority:	alarm
Category:	A
Short Text:	GUARD ZONE INTR
Long Text:	GUARD ZONE INTRUSION BY >>COUNT<< TARGET(S)
Reason:	Some targets entered a defined guard zone.
Impact:	Danger of collision!
Troubleshooting:	When assessing the situation at ECDIS, ensure that the target overlay is displayed. Check all dangerous targets for potential collisions and perform all necessary actions according to the rules to avoid these collisions.

9.2.6 LOST REFERENCE TARGET

Priority:	warning
Category:	B
Short Text:	LOST REF TARGET
Long Text:	LOST REFERENCE TARGET
Reason:	The target selected to be the reference target for SOG/COG calculation was lost.
Impact:	SOG/COG cannot be calculated from the reference target any longer. If no other SOG/COG input is available, tracking performance will decrease.
Troubleshooting:	Select another reference target. If no other reference target and no sensor input for SOG/COG is available, switch to water stabilization or enter the values manually.

9.2.7 MAX >>COUNT<< TARGET(S)

Priority:	warning
Category:	B
Short Text:	MAX >>COUNT<< TARGETS
Long Text:	MAX >>COUNT<< TARGETS
Reason:	The processing capacity of the integrated target management is exceeded.
Impact:	New targets (ARPA, AIS) cannot be processed. Collision avoidance functionality is degraded.
Troubleshooting:	Adjust the automatic acquisition zones and AIS the AIS transponder such that less targets have to be processed. Delete targets which are no longer needed.

9.3 Alert Escalation

A Warning Message escalated to an Alarm Message after 60s (factory setting).
If possible the user can be extended the escalation time up to 5min (see Synapsis Service Manual 4169 section 3.1.7).
This time is user default via the service tool settings. These setting will be done in combination with the INS installation according with the operator request and the RAn service.
Exception:
The track control warnings "SWITCH TO VALID SPEED SOURCE" and "SPEED SENSOR VALID" are not escalated to alarms, but repeated as warnings as required for track control.
Alarm escalation take place after 60s (factory setting). In this case the INS send the Emergency Call via the BNWAS serial interface. These setting will be done in combination with the INS installation according with the operator request and the RAn service (see section 1.3.8.2).
If possible the user can be extended the escalation time up to 12min (see Synapsis Service Manual 4169 section 3.6).

9.4 Responsibility Transfer of Alerts

Synapsis supports the “responsibility take over” functionality as defined in IEC 61924-2. If multiple alerts (e.g., from different sources) refer to the same failure condition, the most descriptive one of these alerts takes over the responsibility for a failure condition. The other alerts are automatically set to the state “responsibility transferred”.

The following types of alerts cause a transfer of responsibility:

- a “>>SENSOR<<: FUNCTION LOST” alert of a certain sensor takes over responsibility for the “>>DATA<<: NOT AVAILABLE FROM >>SENSOR<< (NOT) IN USE”

- The “HEADING: NOT AVAILABLE” alert takes over responsibility of the “SYSTEM UNSTABILIZED” alerts of all Radar displays as well as the “POSITION AND SPEED ARE NOT REFERENCED TO CCRP” alert.

- “MFCx: HOST LOST” takes over responsibility of the “FUNCTION LOST” alerts of all applications running on that MFC and all sensors connected to that MFC.

- New target alerts are set to state “responsibility transferred” if the integrated target management detects the target as not being “new” because it is associated with an already known target. New target alerts are rectified when they are acknowledged or responsibility is transferred.

10 Power Supply Requirements INS

The Integrated Navigation System (INS) has to be connected to the Main Ships Power Supply and to the Ships Emergency Power Supply. This applies to all INS Components (depending on the applying carriage requirements (number of consoles for RADAR and ECDIS) inclusive 1 Antenna, 1 Transceiver as well as for the Autopilot if part of the INS. Furthermore 1 Gyro, 1 Speed Sensor and 1 Depth Sensor must be connected to an Uninterruptible Power Supply (UPS).
The performance data of the relevant equipment must be considered.

Original IMO requirement:
(MSC 252(83)/13.4.1) *Power supply requirements applying to parts of the INS as a result of other IMO requirements shall remain applicable.*
(MSC 252(83)/13.4.2) *The INS including the sensors for position, speed, heading and depth shall be supplied:*

1. from both the main and the emergency source of electrical power with automated changeover through a local distribution board with provision to preclude inadvertent shutdown; and
2. from a transitional source of electrical power for a duration of not less than 45 s.

The INS and the sensors can be connected to an UPS that can be also provided by the shipyard. The power supply concept must ensure that any single point of failure condition (e.g. failure of main power supply or failure of transitional power source) may not cause any system failure or shutdown. This may be achieved by the use of several UPS, each individually fused against short circuit, or other means.
Additional class notations of classification society's rules may require extended power supply concepts. This has to be clarified with the relevant classification society.

10.1 Power Supply Requirements INS supplied with separate Power Net

The INS power supply is divided into two separate power nets. In case of a failure of one power net the INS will still be operational (see Figure 10-1).

The reliability of the power nets might be increased by using uninterruptable power supplies (UPS). This is only necessary if the existing power sources (generators) are not reliable enough.

The supply of the sensors is also divided by the two power nets.
Sensors that exist twice for redundancy purpose shall be connected to both power nets (e.g. GPS).
The power distribution should be realized via a Switching Board see section 10.1.1.

The UPS can be realized from the shipyard or from RAn (optional contract).
For UPS requirements see section 10.1.2.

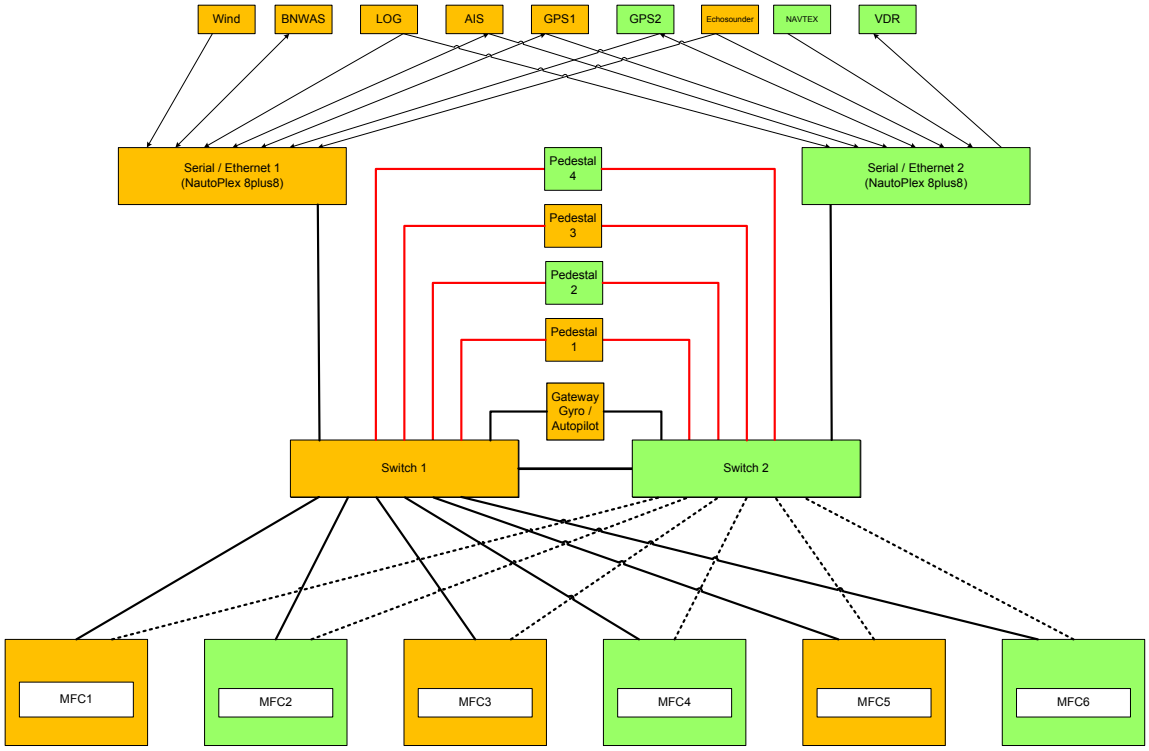


Figure 10-1 General Network Setup

10.1.1 Switching Board

Each power net is distributed to its participants using a switch board. Depending on the project a switch board might be already realized by the shipyard (see Figure 10-2).

The switch board is the central point where all participants of the INS can be switched on/off. Switching of the units during operation might be necessary in case of a unit malfunction (e.g. a console or a switch hangs up).

Figure 10-2 Switching Board

10.1.2 UPS Requirements

The UPS is used to increase the reliability of the power supply. The size of the UPS is dependent on the calculated expected load.

Table 10-1 UPS specification

Item	Power Consumption (W)	Information
Switch	20	
Console	200	
Ethernet Serial Converter	5	
Sensors	ship specific	
Radar Pedestal	1000	
Example for total power net 1	2625	(Switch + Ethernet Serial + 3 MFCs + 2 Radars)
Example for total power net 2	2625	(Switch + Ethernet Serial + 3 MFCs + 2 Radars)

It is recommended to integrate the failure contact of the UPS into the Synapsis System to raise an alert in case of an UPS disturbance. For integration see Synapsis Service Tool Documentation No. 4280 section Configure Integrated Relays.

10.1.3 Participants

10.1.3.1 Console / MFC

Each console is supplied witch 230VAC. Additional Voltages within the console (24VDC for Small Marine Computer and optional Ethernet Serial Converter) are generated within the console.

10.1.3.2 Switch

The Switch is supplied with 230VAC.

10.1.3.3 Serial / Ethernet (NautoPlex 8plus8)

The Serial Ethernet Converters shall be situated within Console 1 and 2. They are supplied in parallel to the Small Marine Computer sharing the 24VDC inside the Console.

11 Fulfilled Carriage Requirements of INS

The INS fulfils the following carriage requirements:

- Radar / collision avoidance (Res. MSC 192(79))
- ECDIS / route monitoring (Res. MSC.232(82))
- Track Control, if installed (Res. MSC.74(69) Annex 2)

The installation of INS should be in accordance with

- IMO SOLAS regulation V/15: Principles relating to bridge design, design and arrangement of navigational systems and equipment and bridge procedures,
- MSC/Circ.982: Guidelines on ergonomic criteria for bridge equipment and layout,
- Sn.1/Circ.265: Guidelines on the application of SOLAS regulation V/15 to INS, IBS and Bridge design,
- SN.1/Circ.288: Guidelines for bridge equipment and systems, their arrangement and integration (BES).

12 Power Supply Failure

If the board power supply is disturbed, the UPS (see chapter 10) will be activated automatically.
INS bridges without UPS protection shut down (see chapter 13).
The current alarm and warning monitoring situation is lost.
After a system recovery time (4 minutes) the alarm history is present again.
The CCRS data processing fulfils a system check, active alarms and warnings are restored and will be displayed via the alarm window and central alert management display.
The alarm history data updates automatically.

13 System Recovery Timer

The Radar, ECDIS, Conning applications on a MFC are available 3 minutes after a reboot, Radar transmit mode is ready after 4 minutes.

CCRS data evaluation is available 1 minute after the BIP process has been started.

By default, system monitoring and INS status information is available 3 minutes after the BIP process has been (re-) started.

14 Reference to IEC 61924 INS Performance Standard *(INS specific)*

14.1 Latency (IEC section 5.3.3.2)

Latency of sensor data has to be avoided as far as possible; examples of latency and their influence on navigation are given below:

14.1.1 Radar Tracks

The update rate for heading data has significant impact on the tracking process. A heading update frequency of at least 10 Hz is required to guarantee precise determination of radar target track motion.

14.1.2 Track Control

Accuracy of the track keeping process depends on the availability of position, heading and speed data. To calculate accurate rudder responses an update rate of at least 1 Hz is needed, otherwise precise track keeping will not be possible.

14.1.3 Correlation of Radar Echos

For reduction of clutter and noise correlation methods are applied which are sensitive to heading and speed information provided. Speed update rates of at least 1 Hz are needed in addition to adequate heading information to avoid extinction of existing targets.

14.1.4 High Speed Craft

For high speed crafts even higher demands on the data update rate are to be applied. For Radar the antenna rotation rate has to be increased by a factor of 2 because otherwise the tracking process will not be reliable enough for HSC.

14.2 Required Number of Consoles (IEC section 6.3.1)

The number of consoles needed for safe navigation is determined by several factors:

- Carriage requirements, i.e. size of ship
- Requirements of Classification societies.
- Availability of Multifunction Consoles (MFC)
- Availability of Track Control

If multifunction consoles are part of the bridge system it must be possible to select from the tasks available by means of a simple operator action (which is two steps). Only if all six INS tasks are available on all MFCs a reduction of the number of consoles can be considered (i.e. less than six).

According to the IEC standard for INS 4 tasks must be available simultaneously in the fore ground, Collision Avoidance, Route Monitoring, Nav Data Control, plus one for redundancy).

Route Planning, Status and Data Display, and Alert Management HMI can be kept in the background.

This leads to a number of 4 consoles needed.
Classification society DnV uses a different terminology for INS tasks and requires 5 consoles, ARPA, ECDIS, Conning, Alarm Management, plus one for redundancy purposes.

Further, it has to be decided if one of the consoles will be dedicated to the track control function.

As a summary it can be said that, 4 consoles should be sufficient to cover INS requirements; however, requirements of classification societies will override this statement.

14.3 Reduction of Single Point of Failure and Minimization of Human Error (IEC section 6.5.2.2)

The following list gives an overview of the implemented measures and methods to avoid single point of failure and human error:

1. All six tasks are available at all times (Route Planning, Route Monitoring, Collision Avoidance, Nav Control Data, Status and Data Display, Alert Management).
2. Sufficient number of consoles (minimum 4).
3. Fall back arrangement for automatic control function, i.e. track control; Track control → heading control → manual steering.
4. Back up for following information: position, heading, speed, Radar, Chart Data Base.
5. Smoothing of jumps in case of failure: integrity checks, multiple sources, Consistent Common Reference System (CCRS), Dead Reckoning.
6. Clear indication of faulty and not available data.
7. Provision of alternative sensors and indication of their availability.
8. System overview (on at least one console) for consoles, tasks, interfaces (including Alert Management), sensors (see also 6).
9. Avoidance of Power Interruptions by means of UPS.
10. Provision of Radar tracking and AIS targets.
11. Clear indication of manual settings, manual control, manual measuring (of e.g. position).
12. Undo button and queries “Do you really want to …”

14.4 Style Book (IEC section 6.5.1.2)

The Style Book will define which design elements are used to implement the layout of user interfaces for all INS applications. These elements are proprietary of Raytheon Anschütz but with regard to size and shape certain requirements from international standards have to be considered (IEC60945, IEC62288).
In addition, terms and abbreviations as specified in standard IEC62288 have to be used.

14.4.1 General Screen Layout

An identical basic screen layout is used for all applications, Route Monitoring, Collision Avoidance, Nav Data Control, and Alert HMI. The display area is subdivided into three parts, a main center area and two areas adjacent to the left and right edge of it.

Depending on the application the center area is used for display of the most essential data, while the two other areas are used for additional data and user interfaces, see Figure 14-1, Figure 14-2, Figure 14-3, Figure 14-4.

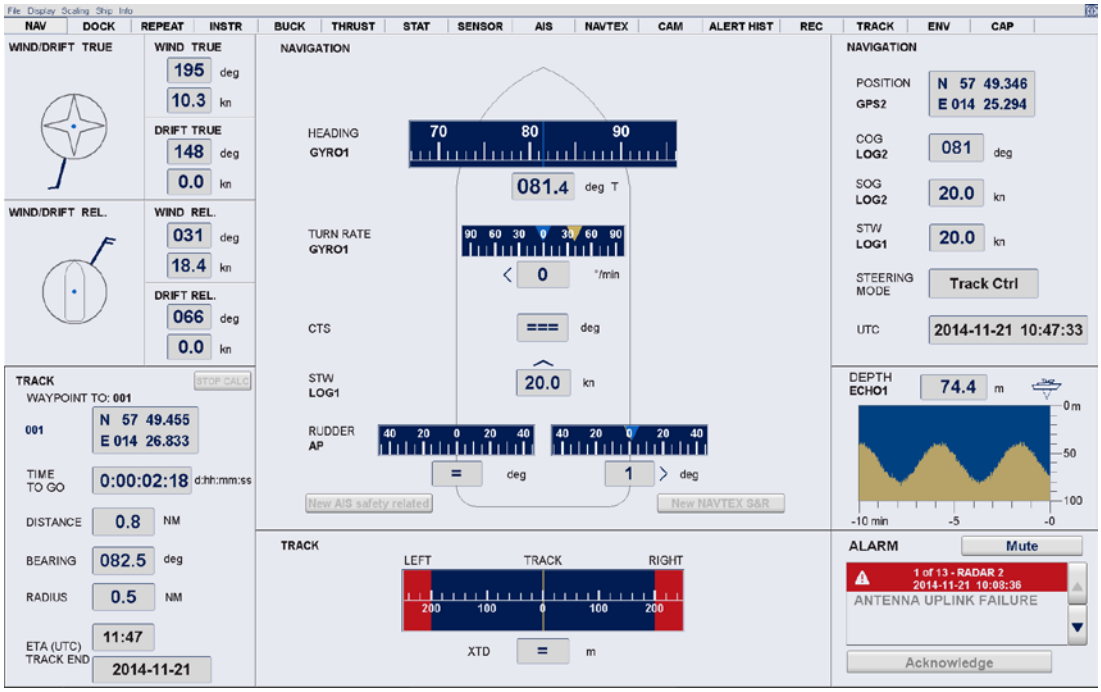


Figure 14-1 Screen Layout Conning

Figure 14-2 Screen Layout Conning Selection Page

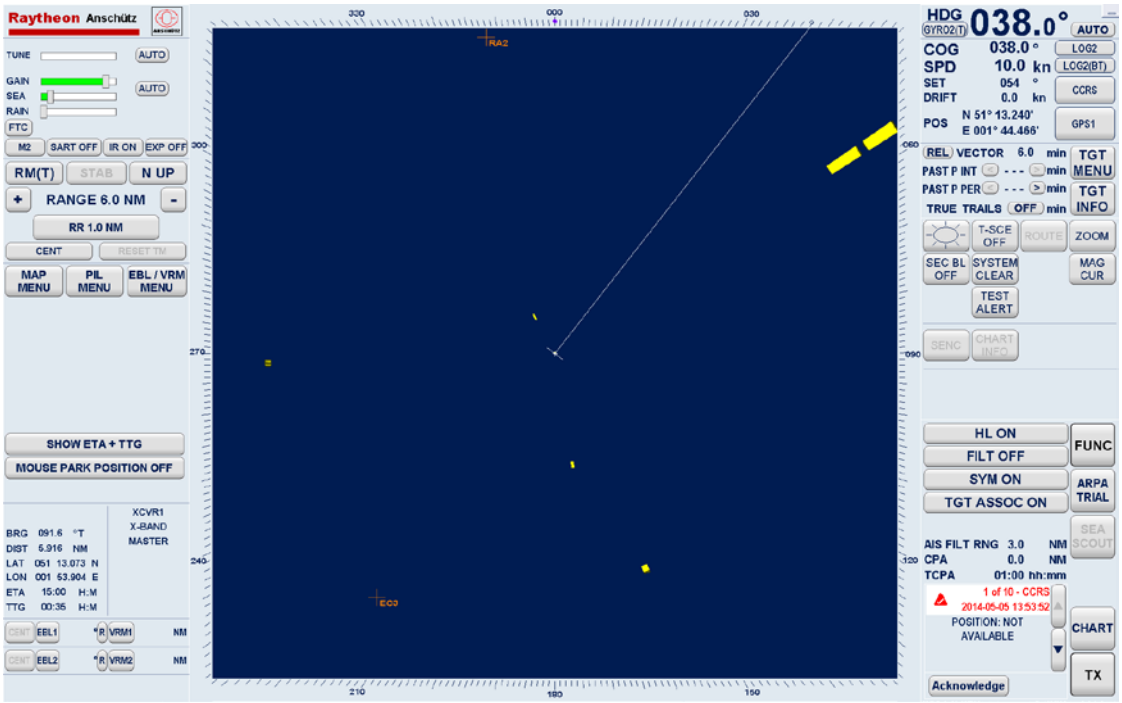


Figure 14-3 Screen Layout Radar

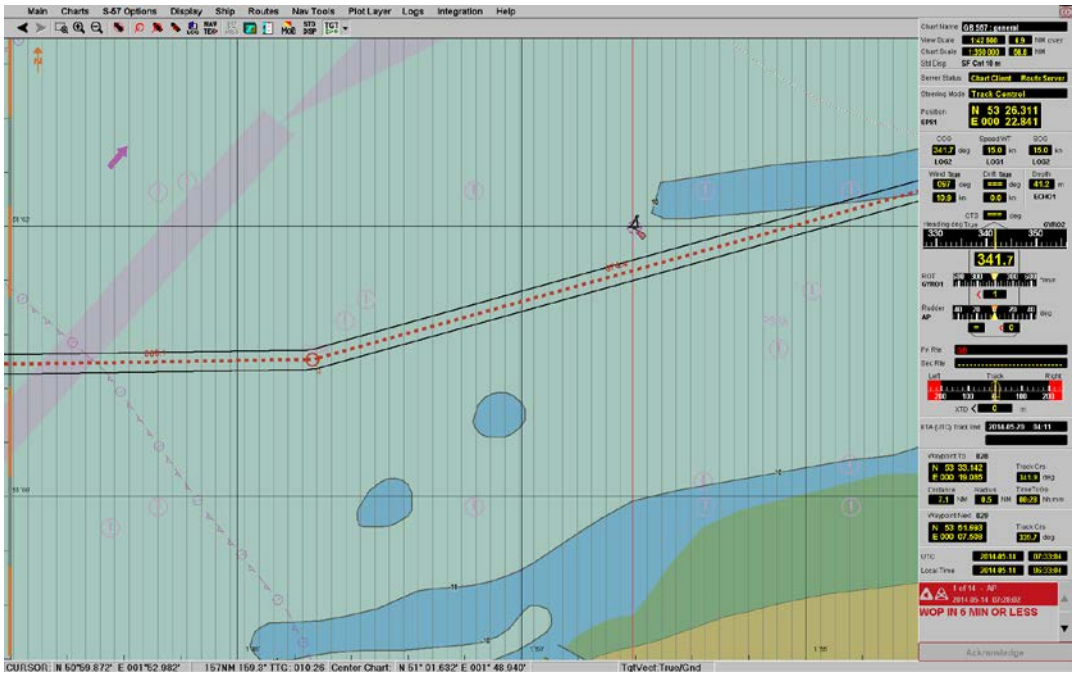


Figure 14-4 Screen Layout ECDIS

14.4.2 Color Palettes

From Figure 14-1, Figure 14-2, Figure 14-3, Figure 14-4 it can also be taken that basic color shades are applied for all tasks.

Figure 14-1, Figure 14-2, Figure 14-3, Figure 14-4 demonstrates this for a daylight color palette, but the concept is the same for all other palettes in use, like night and dusk. On top of a unified background color other elements are displayed with a corresponding color set.

14.4.3 Alarm Window

All applications are equipped with an alarm window which is located at the bottom right corner of the display area.
General shape and layout of the alarm window are identical for all tasks, see Figure 14-5.

Figure 14-5 Alarm Window

The alarm window application incorporates another operating element which is unified over the complete range of display tasks; see Figure 14-5 for the Spin Button to scroll up and down alarm messages.

Radar

14.4.4 Sensor Selection Page

A sensor selection page has been designed and is used for Conning (Nav Data Display) and ECDIS (Route Monitoring) same way, see Figure 14-6 and Figure 14-7.

For the Radar (Collision Avoidance Task) a different approach has to be made as there is not sufficient space to arrange sensor selection buttons and sensor data displays; see Figure 14-8Figure 13 3, bottom illustration.

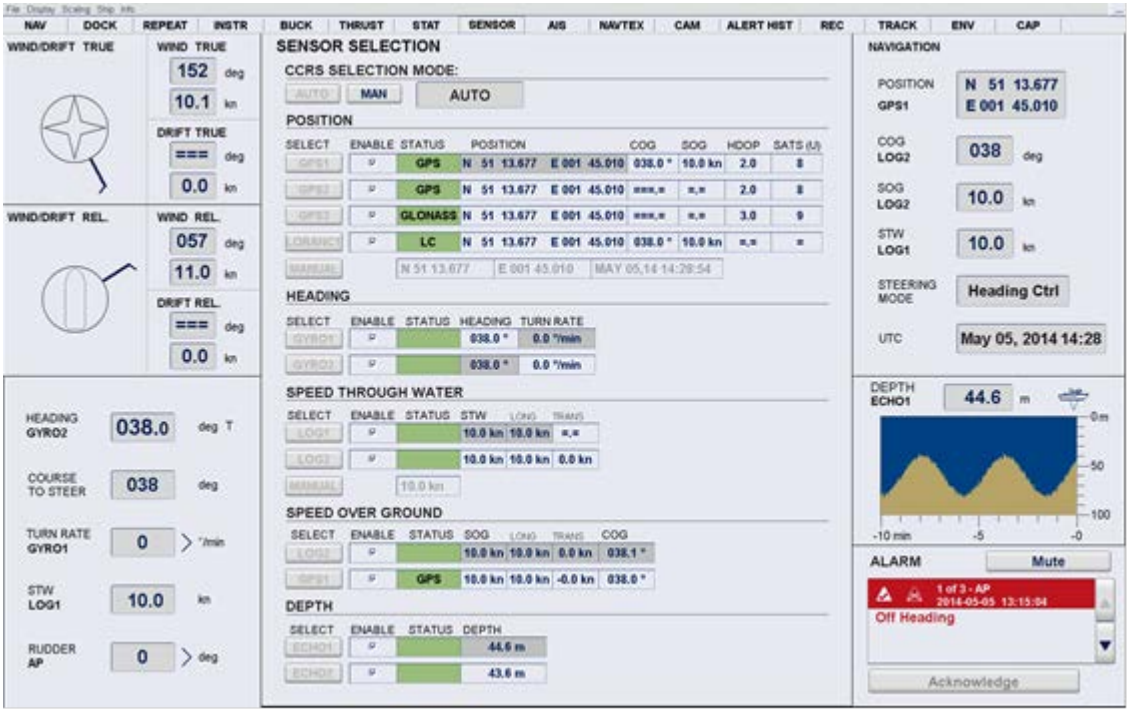


Figure 14-6 Sensor Selection Page Conning

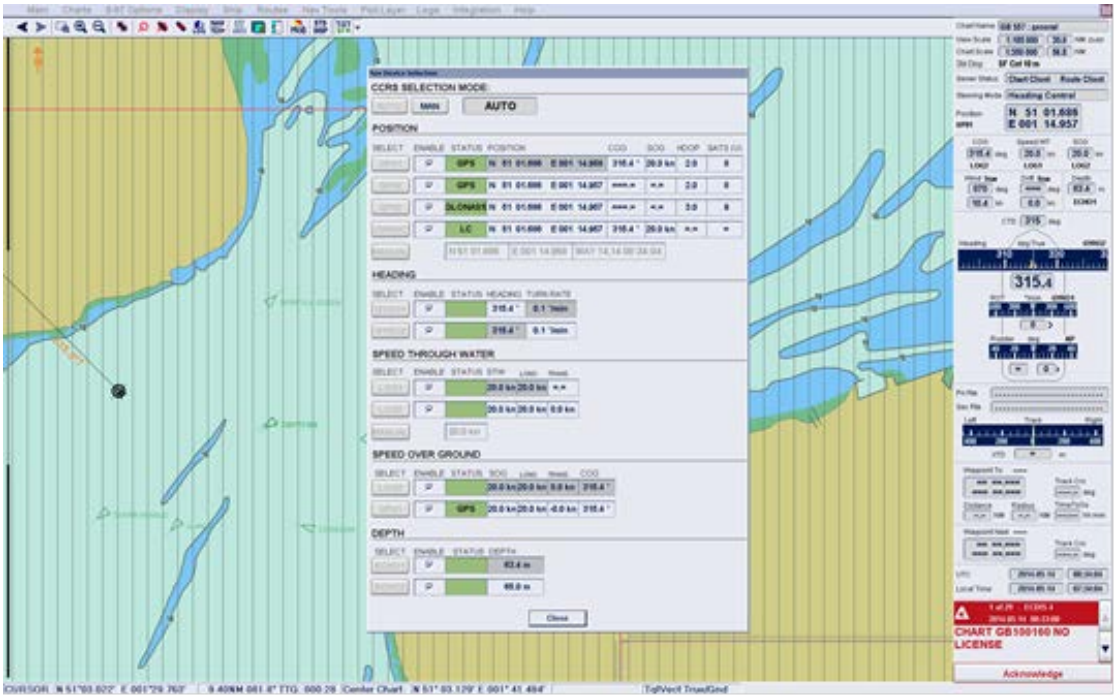


Figure 14-7 Sensor Selection Page ECDIS

Figure 14-8 Sensor Information Radar

14.4.5 Analog Instruments

Nav Data Control display and ECDIS info panel (if displaying the docking version) use the same elements to display data in an analog presentation.
Examples for analog instruments are e.g. rubber bands to show heading, RoT, and rudder settings, or weather vanes to display wind and, by a similar graph, drift information, see Figure 14-2.

14.4.6 Navigation Page with Ship Symbole

As illustrated in Figure 14-9 the vessel's motion data are grouped around the silhouette of a ship. The same graphics is used for the conning display center main page and for the ECDIS info panel.

This graphics is also shown in Figure 13 4.

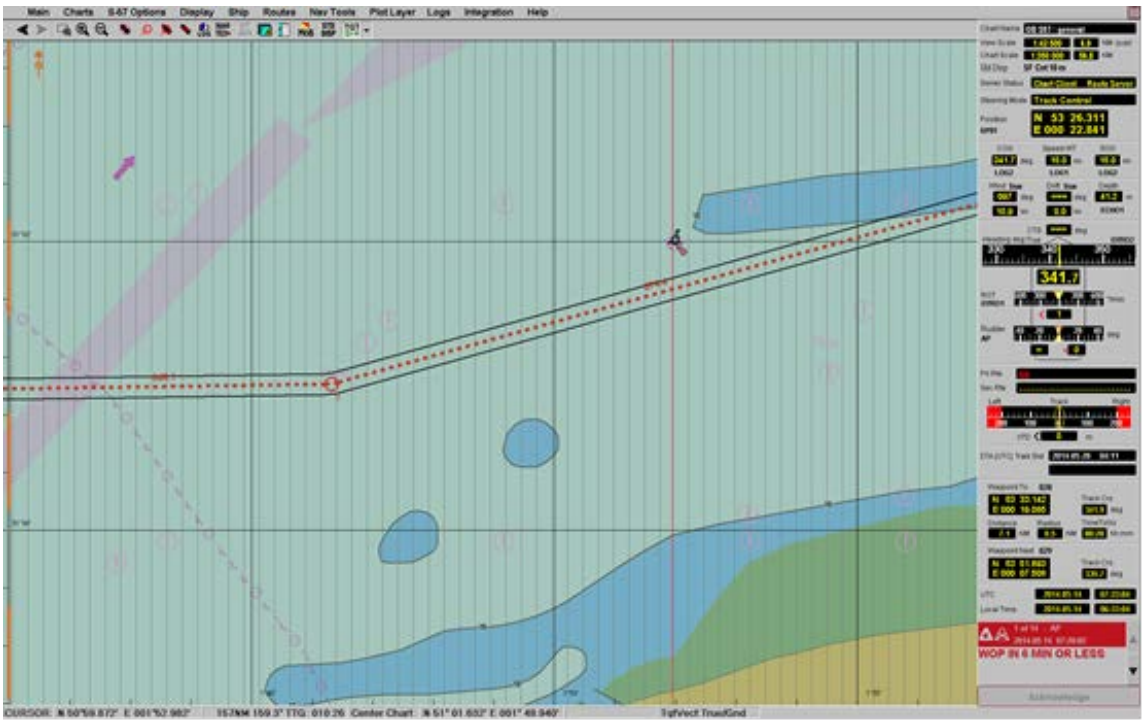


Figure 14-9 Motion data around silhouette of vessel

14.4.7 Other Display features for Conning Display

For special Conning pages custom-designed displays have been designed, e.g. pointer instruments, graphs, these are listed in Figure 14-10.

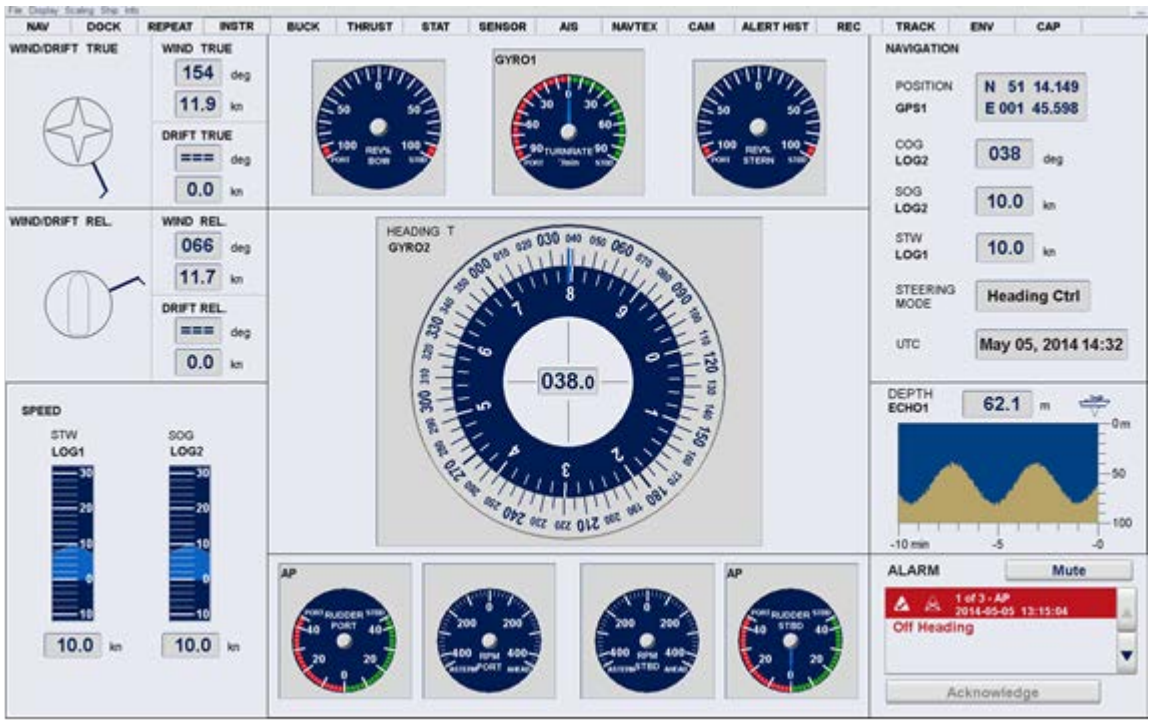


Figure 14-10 Pointer Instruments Graphs

These elements are available for specialized Conning displays only.

14.4.8 Tool Bar for ECDIS

Another operator element is uniquely used for the ECDIS (Route Monitoring, Route Planning), the so called Toolbar; see Figure 14-11.

Figure 14-11 Toolbar

Buttons are used as short cuts to frequently used functions.

14.4.9 Pull Down Menu

Windows like pull down menus are implemented into the ECDIS and Conning applications, see Figure 14-12. For Radar this element is not suitable as essential information could be covered and this is not in accordance with the Radar Performance Standards.

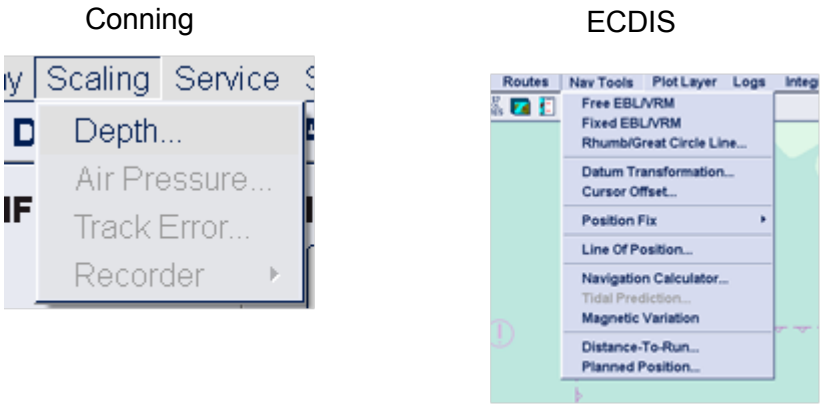


Figure 14-12 Pull Down Menu Conning and ECDIS

14.4.10 Alert Management HMI

For INS a central alert management is required and with it a dedicated HMI to display and handle upcoming alarms. The Alert Management HMI is a unique feature and therefore has its own design which is not shared by any other task or application of the INS, see Figure 14-13.

Figure 14-13 Alert Management HMI

14.4.11 Alert and Acknowledge Button

Five special design elements come with the Alert Management HMI, the alert and the acknowledge button, see Figure 14-14.

Figure 14-14 Alert Button and Acknowledge Button

14.4.12 System Status Page

The System Status Page is a unique feature and therefore has its own design which is not shared by any other task or application of the INS, see Figure 14-15.

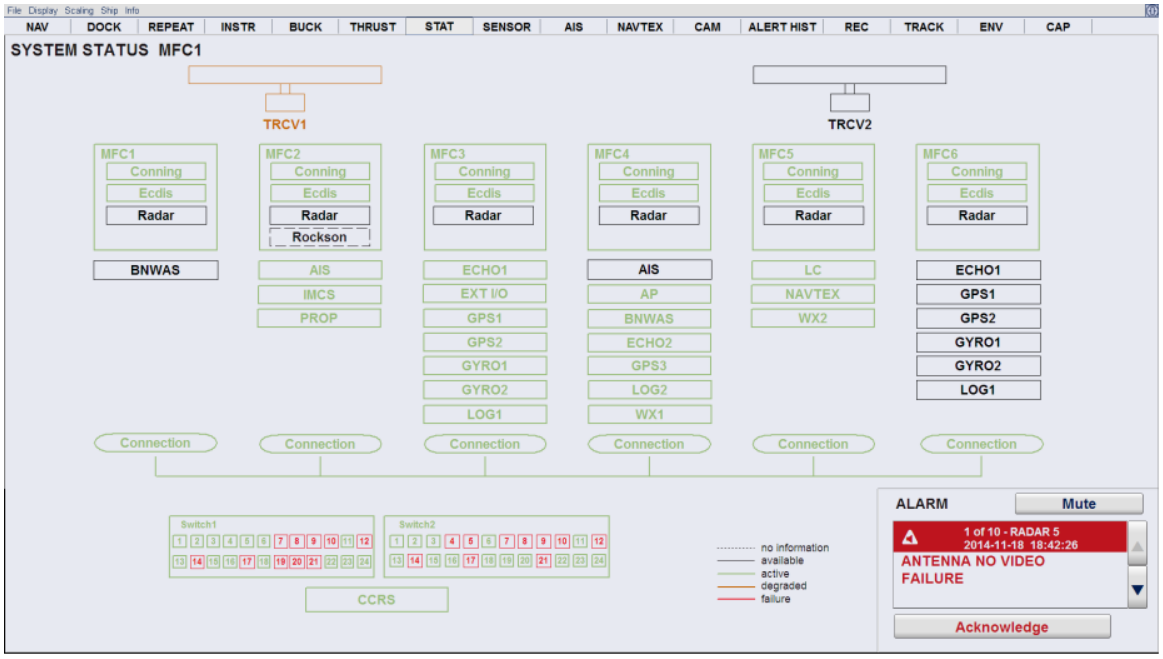


Figure 14-15 System Status Page

14.4.13 AIS and Navtex Messages

To fulfill the INS Performance Standard two pages have been designed to display AIS safety related and NavTex messages. These pages are based on the same design principles, see Figure 14-16.

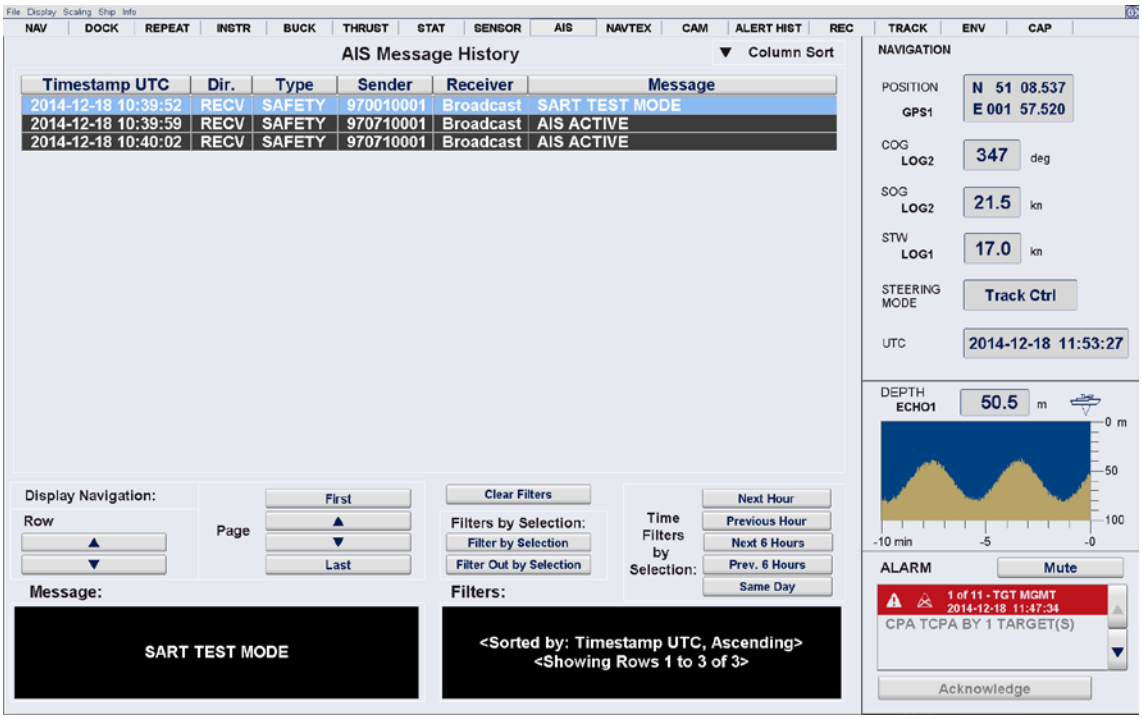


Figure 14-16 AIS Messages Page

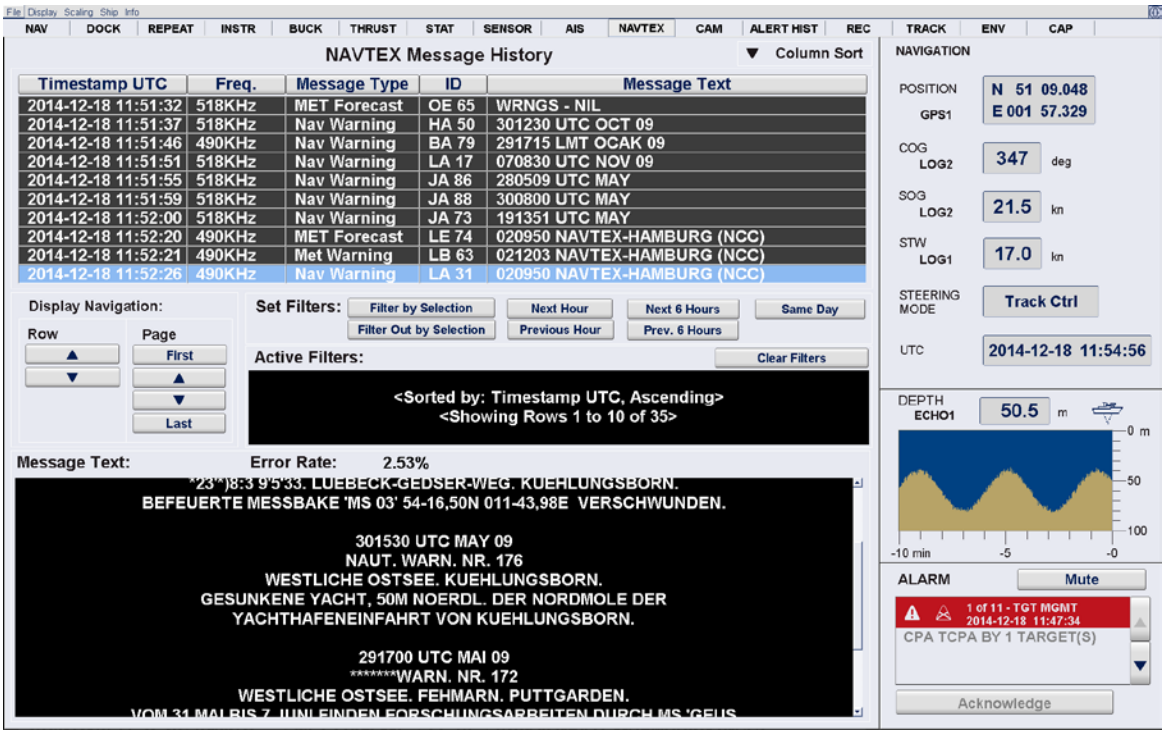
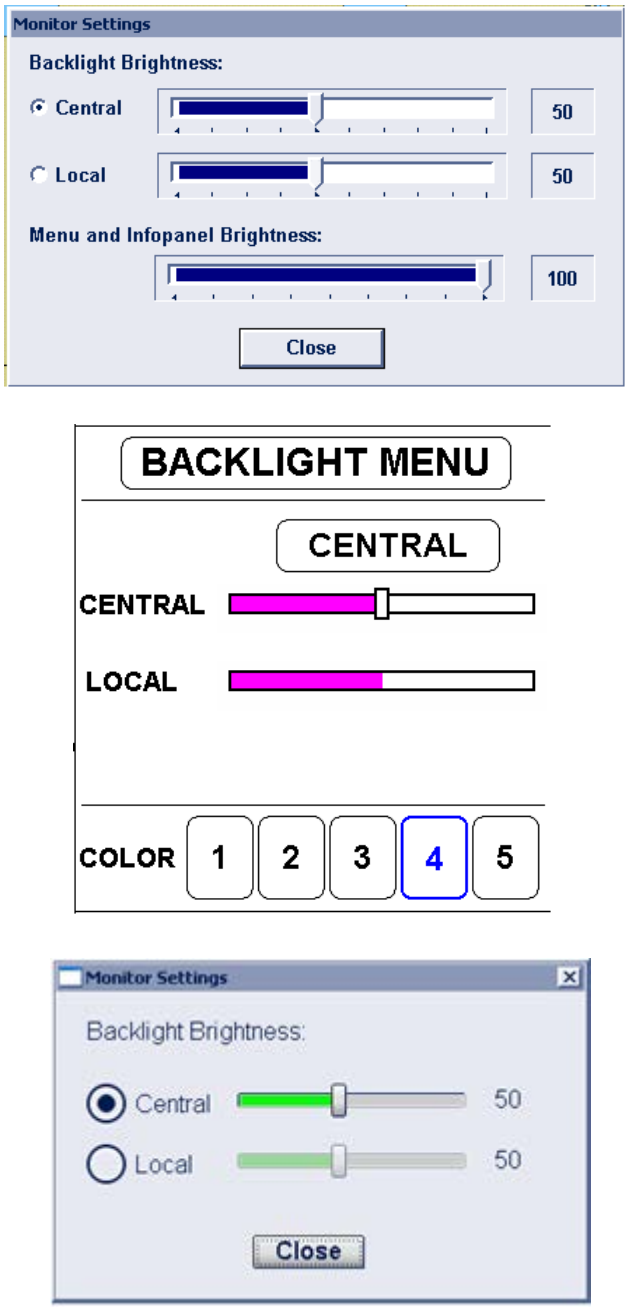


Figure 14-17 NAVTEX Page

14.4.14 Monitor Settings

The dimming of the bridge's main displays is possible from any of the main tasks. The adjustment elements, like sliders, are the same for ECDIS, Radar and Conning, see Figure 14-18.



ECDIS

Radar

Conning

Figure 14-18 Monitor Settings

14.4.15 MCF Task Switch

The MFC Task Switch is placed on the top right corner of the display.
If not used the MFC Switcher shrinks to a little icon. If selected, the Switcher expands to a pull down menu providing a set of application buttons. The application buttons are equipped with Task identifiers; these Task buttons allow direct access to special ECDIS and Radar functions and Conning pages.

Status indication:

Status color	Information
Green	The application is working correctly
White	The application does not work
Yellow	The application is in the startup process
red	The application is disturbed

The context menu is used to control the applications for Radar, ECDIS and Nautoconning and the MFC processor.

Control	Information
Conning	Calling up the Feature
Radar	Calling up the Feature
ECDIS	Calling up the Feature
Feature	**Information**
Restart	The application will be closed and restarted again
Start	Start the application
Shutdown	Shutdown the application
Kill	The application will be terminated directly
Service	Calling up the Synapsis Service Tool
Close All	All applications will be closed. The EggShell Utility Selection window appears after some seconds.

The MFC Task Switcher is another unique and central operating element which is available for all tasks, see Figure 14-19.

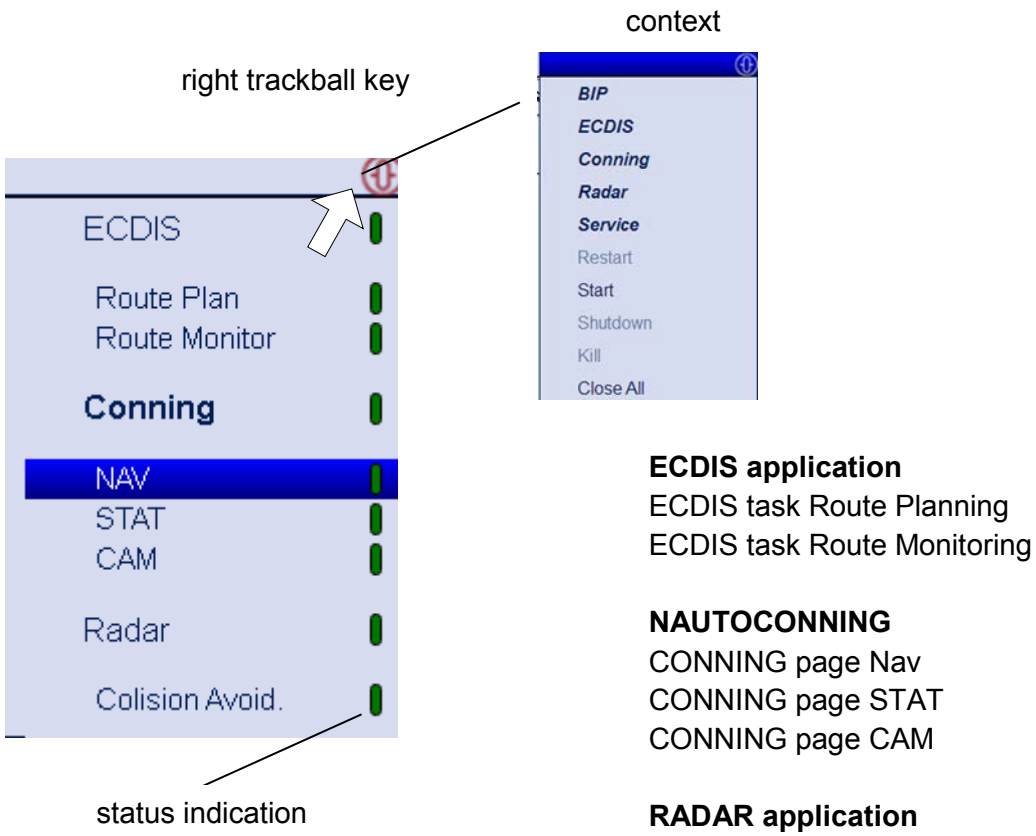


Figure 14-19 MFC Task Switch

14.5 License Convention

14.5.1 License Convention for

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libjpeg

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